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ENGINEERING AND
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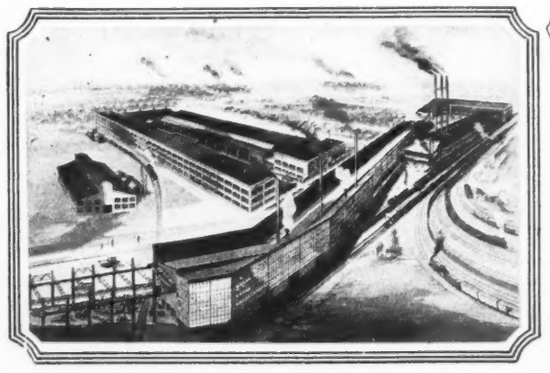

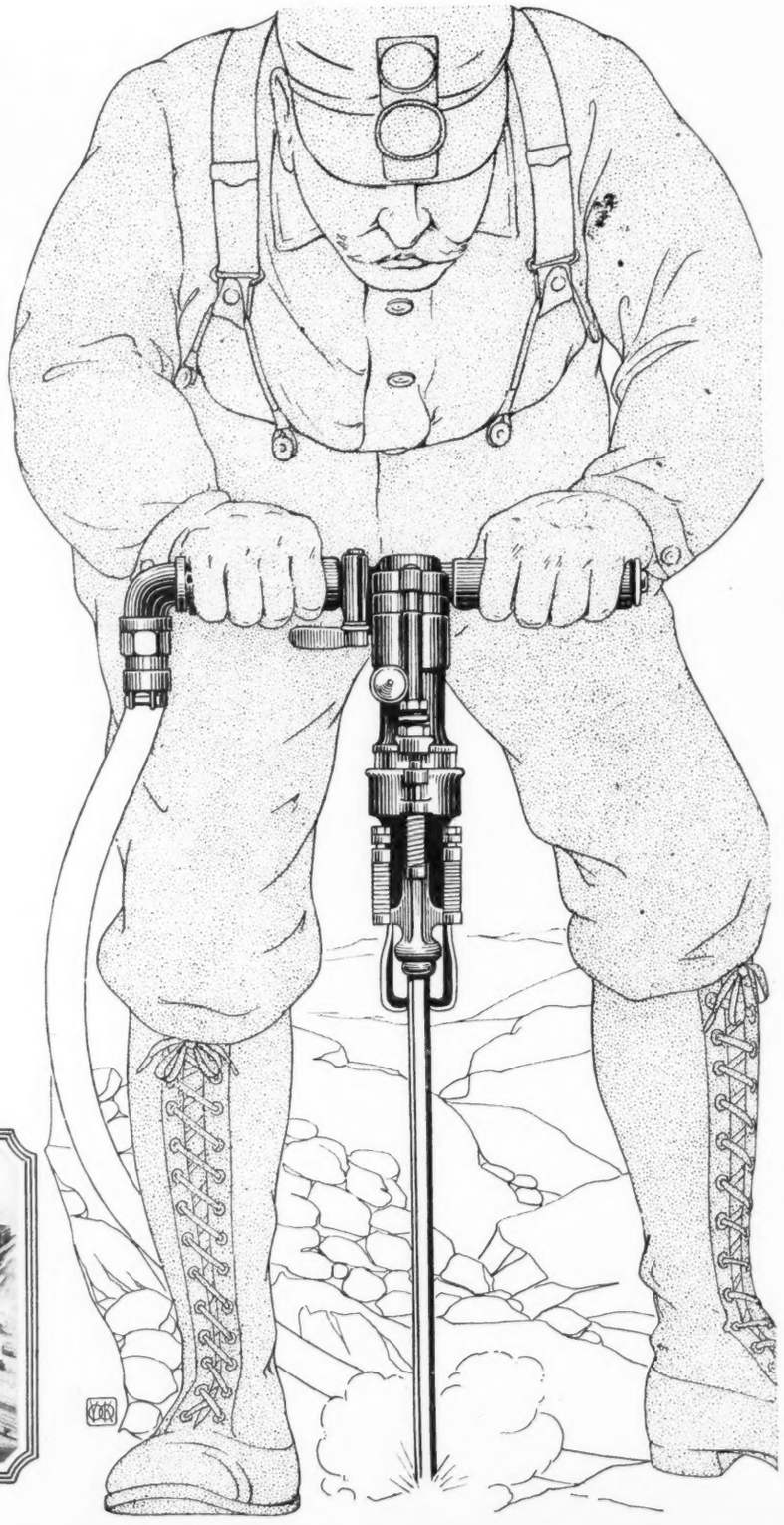

CLEVELAND ROCK DRILLS

ENGINEERING AND
MINING JOURNAL

JOSIAH EDWARD SPURR, Editor

Volume 123 | New York, January 29, 1927 | *Number* 5

Aluminum Price Cut

WHY the Aluminum Company of America has cut its prices 1c. a pound on aluminum ingots of all grades is a matter for speculation. Various theories have been advanced to account for the act on the part of the "trust," which is often supposed to have the aluminum world beneath its thumb. One of these is that it is due to the lack of demand and that the inventories of various consumers on Dec. 31 showed sizable stocks of metal. Another points to heavy imports and the large amount of secondary metal that is making its appearance. Still another suggests the influence of certain automotive interests who would use more of the light metal in building cars "if the price were right." Possibly all of these played their part in shaping the Aluminum Company's decision. The president of the company, Mr. Davis, in a statement recently attributed to him in the press, said that demand had slackened in 1926. This slackening, however, if actually a fact, was probably confined to a certain industry or industries which found the ruling price too high.

Throughout the world the aluminum industry is making rapid strides. Last year almost half a billion pounds was produced of this metal, which a little more than a generation ago was held a novelty. Of this somewhat more than half was produced at home. Despite this the world has nowhere near enough, and new capacity is being developed at home and abroad as rapidly as the wherewithal—that is, the money, power, and raw material—can be obtained. Existing companies are extending their operations—in Canada, Norway, Italy, France, and Switzerland. Elsewhere new industries are springing up—in Spain, Hungary, Russia, and Japan. As a result it is estimated that within the next three years or so the total world capacity will be about 1,200,000,000 lb. per annum, or more than double that at present.

One immediate aspect of this tendency to expand is that Germany, who before the war produced only 1,500,000 lb. per year and who now has an annual capacity of some 43,500,000 lb., as stated in the article on pages 210-212 of this issue, is steadily becoming more prominent as an exporter. Moreover, France has new works that are just about to start, which will make it possible for her to do a greater foreign business. The Chute à Caron plant, in Quebec, has already begun production and ultimately will be making a colossal output, almost equal in fact to the world's production now. This plant, however, is controlled in Pittsburgh.

Speculation as to what extent new foreign business enterprises may exert an influence on the price policy of the Aluminum Company of America is rendered difficult because of the lack of knowledge as to how far they are controlled or influenced by the Pittsburgh interests. The new price basis of the Aluminum Company is below the price that importers have been quoting by half a cent. The company is well able to make further cuts if it sees fit to do so.

Pity the Miner, in the Mine So Deep!

NO LESS AN AUTHORITY than Arthur Brisbane observes editorially: "Russian census inspectors have discovered a new religious sect—Russia has dozens of queer ones. The men and women spend their time in caves underground, praying. How could they imagine the good Lord, who gives sunshine and green fields, wants us to go underground, the Lord knows."

The Lord knows. Herbert Hoover remarked recently that the popular sympathy with the miner was misplaced —that most of them would rather work underground than on the surface; and as for himself he still loved the smell of the underground. Indeed, many another who recalls the fragrant clean odor of fresh rock will agree with Hoover rather than Brisbane, and will observe that only the Lord knows how a man could prefer the rattle and hallabaloo of New York, and editing a paper like the *American*, to the mountains and the peaceful caverns of the mines. Here the miner

> "Fears no more the heat of the sun
> Nor the furious winter's rages."

Summer and winter—at most mines—he works in an equable temperature, with mild but sufficient light. With an interesting and often exciting occupation of treasure hunting, the miner wants only a fair wage and a good house, and opportunity for his children, to be content; and would not exchange his lot for the many-towered beehives and antheaps of the crowded centers of population.

The Reduction of Silver Coinage

AS AN INDICATION of the trend of events, it is worth noting that the new minting of small coinage by France, amounting to 88 millions of francs, will exclude the use of silver. Fifty million francs, in pieces of one, one-half, and two, are to be of bronze; while the smaller denominations will be largely of nickel. Aluminum will also enter into the composition of the coin alloys.

This, in view of the fact that in the past an important market for silver has been for coinage, is of unusual significance. The war forced a revolution and broke the tradition of silver small coinage. The current use of gold in every-day exchange and trade had long before become all but obsolete, in all highly advanced countries, because of the systematization of credit and the greater convenience of paper certificates of gold value. Even silver certificates took the place of silver dollars in the United States, the silver dollars being retained longest in the West, from which last stronghold they have now mainly disappeared. A rich country like the United States has not thought of calling in its silver small coinage, although the reduced weight, combined with the lowered price of silver, render the coins worth only a fraction of their face value, and therefore acceptable only as sym-

bols and promises to pay their face value. They have indeed entered the same class of money as are the paper bills. France and other countries discovered this under the stress of poverty; and having waked up to the fact that coins of cheaper metal were as good a medium of small change as those of silver—even debased silver coins—France evidently does not propose to be extravagant for the sake of a tradition.

The expansion of modern business methods, of government credit and bank stability, apparently means the progressive diminution of the current, hand-to-hand use of the precious metals. In more primitive times, and still in more primitive countries, such as the countries of the Far East, real money in the original sense is necessary—but as even these become financially organized, symbols in metal or paper are substituted. The function of gold and silver then becomes that of lying in government vaults and banks, as a proof that the symbols really represent precious metal and may be redeemed as such: and that of being transferred from government to government and bank to bank, in the final adjustment of balances. This function tends to restrict itself to gold, and to ignore silver.

A Necessary Adjustment in Power Drives

TODAY the mining industry finds itself at a stage where there is a ready acceptance of the idea of electrification. It is no longer necessary to draw up elaborate plans or compile long lists of figures to show the economic advantages of electric-power drives. Yet this situation daily places a bigger and more important responsibility upon the electrical engineer than is generally believed.

Time was when electrical men believed that once they were able to win their company over to the idea of electrification their biggest battle would be over. This is hardly true, because the more electrical apparatus that is employed at a plant the greater become the responsibilities of the electrical engineer. It is he who must answer for many of the losses of production, delays to operation, and even losses of life and property which occasionally do occur. To perform his duties, in this new day, in a manner that will enable him to obtain for his company the fullest advantages of electrical apparatus, he must be given the opportunity to sit in at conferences when operations are considered. Operating problems should be discussed with him, designs of new structures should be planned properly to accommodate and permit the ready installation of electric drives, controls and distribution systems. It is also true that he should be given greater control over the selection and purchase of electrical equipment. The present practice at some large mining properties is to place the authority to buy electrical equipment in the hands of a purchasing agent. His usual method is to secure competitive bids from many manufacturers and often select the cheapest equipment available.

Mining apparatus must withstand most severe service, and when a purchasing agent, without consulting the electrical engineer, purchases electrical equipment he is likely to select unsuitable types.

More careful choice of strong, sturdy, electrical apparatus, under the supervision of the electrical engineer, will result in fewer operating hazards and avoid the necessity for frequent replacements and high maintenance costs.

"Don't Invest Your Money in Mining Stocks"

THE WORDS of the above caption constitute the advice which William Wrigley is said to have given George Young, winner of a prize of $25,000 for swimming the Catalina channel last week. Young, an inexperienced youth of seventeen, will of course be the mark of a large number of get-rich-quick artists who infect the Californian coast, and it is to Mr. Wrigley's credit that he is giving the prize-winner some good advice. Probably, when he mentioned mining stocks, he referred to some of the Los Angeles promotions, or to the vast number of "penny stocks" that are traded in on the numerous lesser stock exchanges of the country. But the advice applies equally to industrial stocks of the same type, and it seems to us that this advice, telegraphed to all the papers in the country and printed by them, places an undeserved stigma on mining stocks as a group.

Two years or so ago the following question was printed in the "Question and Answer" department of a New York publication: "What is your opinion about investment in mining stocks? I have some Tintic Standard, Nipissing, Hecla, Dome, Ohio Copper, Premier Gold, Silver Shield, Miami, and Anaconda." The answer was: "No mining stock is an investment in the strict meaning of the term. All of the stocks on your list are speculations wholly, and none of them has any special appeal, even as speculations. . . . We would get rid of the stocks you enumerate and put the funds into securities of companies of known asset and earning value."

Such advice is as warped as that of the irresponsible brokerage sheet that advises the reader to put his all into some wildcat. A mining stock may be an investment just as truly as an industrial stock; many of them have known assets, and though their earning value is not assured, neither, for that matter, is that of most of even the best industrial stocks.

Mining stocks may be divided roughly into three classes: In the lowest group would be placed more or less fraudulent promotions which no one should buy for their present or prospectively inherent value. In the second class would be included the vast majority of speculative mining stocks of companies that have a chance to make good. Some of them will make good in a big way; most of them will fail utterly. Such stocks are often worth buying, but they are not for the George Youngs; they are a fit speculation for only a small part of any one's funds and for those who know the chance they are taking and can afford it. In the third group are the established and well-managed mines, most of which have a good dividend record and assured ore reserves. There is little if any more risk in buying these than in buying industrial stocks. The small investor takes no more chance in buying stocks of the type of Kennecott, Hollinger, International Nickel, and Anaconda than he does in buying industrials such as American Woolen, Chrysler, Pressed Steel Car, or U. S. Industrial Alcohol.

Mr. Wrigley's advice was good, but it will be misinterpreted by the public. He is a mine owner and a chewing-gum manufacturer, but the last named much more than the first. It would be interesting to know if he considers the first thousand dollars that he put in the chewing-gum business was less of a speculation than the first thousand he put into a mine.

Steel Mills Vs. the Farmer

THE QUESTION was asked recently in an editorial in the *Minneapolis Journal*, "What does it profit us here in Minnesota when the steel mills in Pennsylvania, Ohio, and Illinois have a big year?" The same editorial answered the question in a summary statement wherein great profit is shown. It was further stated that this or a similar question is frequently asked by political agitators in the Northwestern farming states when they have some selfish end to gain.

Taking the case of Minnesota, the steel mills of the East mean much to that state. Minnesota produced in 1926 approximately $100,000,000 worth of iron ore, all of which went to blast furnaces and steel mills. A large part of this sum went to pay Minnesota labor and owners of ore lands. The money received for wages and royalty was spent largely in Minnesota or near-by states for agricultural products.

As a further illustration, since the manufacture of steel began in the Birmingham, Ala., district, about twenty-five years ago, bank clearances in Birmingham have increased 3,200 per cent, bank deposits 1,350 per cent, and real estate has increased in value 1,170 per cent. Industry begets industry, and every additional industrial plant increases the demand for farm products.

It is true that the farmer does not always receive as much for his product as he should, but the fault lies in marketing methods and systems, not in the large industrial plants. Since prosperous steel mills mean a reasonable degree of prosperity for all classes, let us have a continuation of conditions that keep the mills busy.

Home Lighting in Great Britain

ACCORDING to British industry statistics, only 14 per cent of the 10,000,000 homes in Great Britain are wired for electricity. Of the total number of houses 7,000,000 are located in the areas of electrical supply. The Electrical Development Association and the Electrical Manufacturers' Association have initiated a five months' campaign, October to March, to see what can be done to induce house owners to wire the 7,000,000 homes and install electrical appliances. Should this number be completely electrified, the work would call for an expenditure of $560,000,000 for materials and labor for wiring; a like amount for fittings and cables, and perhaps even more for labor-saving appliances. Nearly 60 per cent of all the houses in the United States are wired and in congested areas a much larger percentage.

A movement of this kind augurs well for the copper industry, which at all times is seeking new outlets, new uses, and a wider field of application. Think what it would mean to that industry if 60 per cent of all the homes in the British colonies and Continental Europe could be wired for and lighted by electricity.

There is a large field for expansion in the known uses of copper, so essential in the electrical industry. This has often been called an electrical age. Electricity has accomplished wonders, but there are many homes not even wired. Much remains to be done before the electrical millennium frees the housewife from hours of domestic drudgery that can be eliminated. Houses that are wired should, where the expenditure can be provided for, be equipped with an electric refrigerator, vacuum cleaner, washing machine, radio, fans, small motors for culinary uses, and many other appliances, all of which require copper in their construction.

The Tri-State Controversy

COMMENTING on a new lead-zinc project that has been undertaken in New Mexico by a prominent mining and smelting company, a paper of the Tri-State district professes to see in it nothing more than a "club" over the heads of the Tri-State operators. On its face this is sheer nonsense, induced by the fact that the company referred to happens to be a buyer of ore produced in the district. It is the boast of the Tri-State district that it produces some 70 per cent or more of the country's slab zinc output and that it has years of life ahead of it. On the other hand, the New Mexican operation is of modest proportions and is no different in essential respects from various other projects now being conducted in the West in the effort to make money out of complex zinc-lead ores—ores that formerly presented dubious chances for profitable exploitation, but which now possess commercial possibilities through the development of selective flotation.

Trifling as the comment seems, it is an echo of the "conflict of interest" between miners and smelters in the district, to which the secretary of the local ore producers' association referred in an address at the mining convention in Washington in December. Lack of a metal exchange such as that in London, he said, and lack of confidence on the part of ore producers caused by their incomplete knowledge of smelter sales and operation, had prevented the fruition of any attempt to set up a different scheme for buying ore.

All of this is a controversy now familiar to readers of these pages. The ore producers have, at times past, undoubtedly been at a disadvantage. More recently, things have been somewhat better for them, it is believed, thanks mainly to greater co-operation among themselves. Opportunity for further improvement remains, since dissatisfaction still exists. Efforts are being made to iron out the differences, and continued effort to this end is commendable. After all, the situation is not unusual; a conflict of interest is bound to exist between buyers and sellers in any market.

Spelter and Zinc

LOOKING OVER the daily report of the New York Metal Exchange in last Friday's papers, in an effort to find out the true state of the metal market, one reads: "Spelter, East St. Louis, 6.55@6.60c. for spot and near-by delivery. Zinc unquoted." If this report ever came to the eyes of S. S. Tuthill, secretary of the American Zinc Institute, the Metal Exchange doubtless received a well-merited rebuke. Doesn't the Exchange know by this time that there is no such thing as spelter? Seriously speaking, one really does hear less about spelter, and more about zinc, since the campaign for the shorter term was started a few years ago. An eleven-year-old boy, known personally to a member of the editorial staff for the last eleven years, was recently asked what was meant by spelter. He had never heard the word. With zinc, though, he was perfectly familiar; it was "the place where you wash the dishes."

"Zincking," as opposed to "galvanizing," has not become popular. Until recently, at least, the zinc coating has been so thin on galvanized articles that perhaps it is just as well that the general public has not been reminded that zinc had anything to do with the not altogether satisfactory product.

Pump Drives Must Be Selected With Due Regard to Peculiar Conditions of Service

Economies of Electric Motors Make Them Highly Desirable—Moisture, Temperature, Dirt, Dust, Acid, and Alkali Fumes Cause Operating Troubles Unless Properly Guarded Against

By Edgar Gealy
Assistant Editor

THE RAPID ADOPTION of electrical energy in the mines, mills, smelters, and refineries of the metal-producing industry has presented many varied problems in the application of electric motors to pumps. Inside the mines pumps of various sizes and types must be employed to keep the workings free from normal ground waters, seepage from surface waters, and water encountered in subterranean streams. In some sections of the mining field the amount of this water is as much as seventeen tons per ton of ore mined. When we consider the high specific weight of the ores, the amount of water encountered per cubic foot of excavated space is indeed quite large.

In surface operations we also find pumps of various capacities and types employed in handling dredge materials. In this service equipment suitable for all-year-round operation is required, and it must work satisfactorily in heat of summer as well as in the cold of winter. Though inside the mines the temperature is more nearly uniform, outside dredge equipment must work in temperatures varying between wide limits. Though the damp atmosphere of the mines presents special problems regarding insulation and corrosion, outside equipment must be installed with equal care, because due consideration must be given atmospheric temperatures and other features of protection against overheating, moisture, dirt, and dust.

In mills, smelters, and refineries the importance of water and pumping equipment has become so great that the failure of a pump or its drive might necessitate the shutdown of a whole plant or an essential part of it if duplicate units are not provided. New processes of reclaiming metals and treating ores have increased the problems of motor applications. Special reagents, with their corrosive fumes, quickly penetrate and destroy materials not properly designed or protected.

In addition to these purely industrial applications of electric pumping equipment, we must also consider such service as mill, village, or town water supply and sewage pumping.

All these applications of pumping equipment necessitate the use of various classes of pumps. As each pump possesses certain definite characteristics of performance and may be installed under many different conditions of moisture, temperature, dirt, dust, or corrosive fumes, extreme care must be exercised in selecting the kind of power equipment to drive it.

Electrical energy has a great advantage over other forms of energy in that it can be transmitted from one place to another without undue loss or inconvenience. Steam- or air-driven engines when used to drive pumps are generally wasteful of energy, especially when supplied through long steam or air lines. Investigations at some plants have revealed the fact that steam-operated pumps often use from three to seven times more steam than that necessary to generate the required amount of electrical energy to do the same work by means of an electric motor. Transmission losses, the low efficiency of ordinary steam engines as compared with modern steam turbine plants, and the idle standby losses in steam lines kept hot when the pump equipment is not in service account for much of this difference in

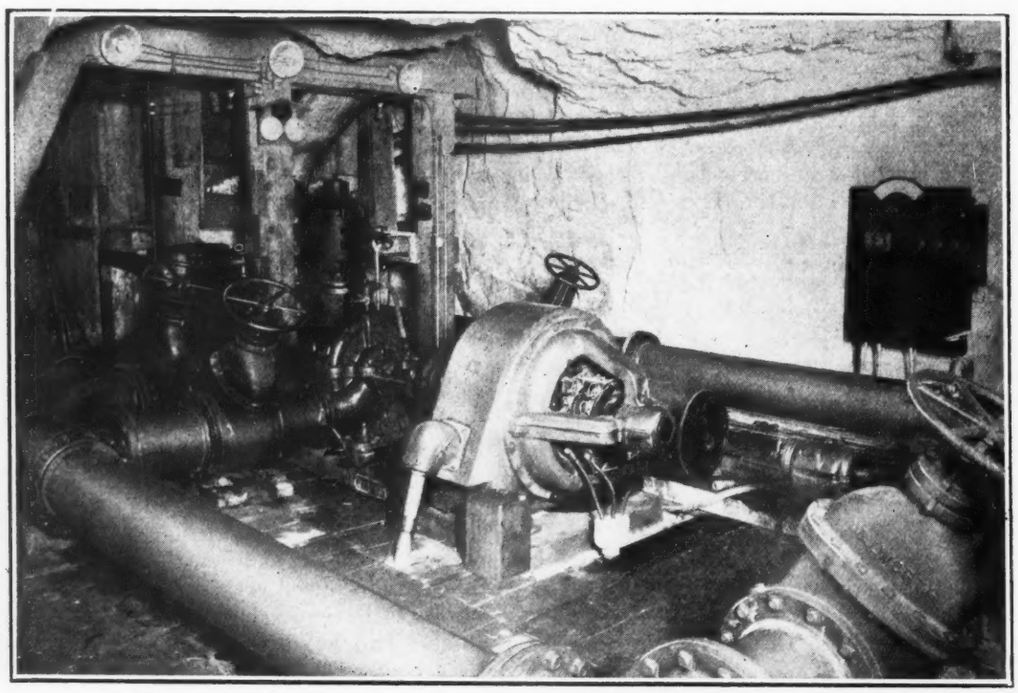

Fig. 1—This view shows one of the new centrifugal pumps installed on the 1,800 level of the Park-Utah mine. These pumps are equipped with motors having a recently designed skirted frame

efficiency between steam- and electrically driven pumps.

If electrical energy is used for other purposes in or about a plant it is generally easy to make taps or extensions to the power-supply lines for the purpose of supplying energy for driving pumps. When this is done the over-all efficiency of the entire power system is made much better than that possible when energy in several different forms is used for various purposes.

Another advantage of the electric power distribution system is its great flexibility. Wires can be readily extended and there is little difficulty in making turns or sharp angles. Special fittings would be necessary in a similarly laid out piping system if steam or air power were used.

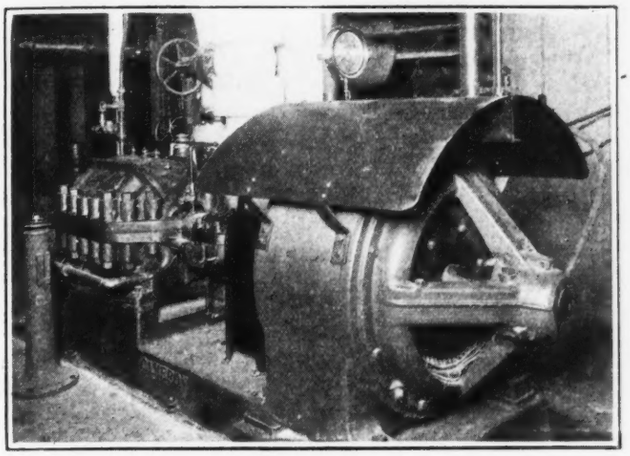

Fig. 2—A home-made protective covering was built for this motor used to drive a five-stage pumping unit

Electric conductors feeding pump motors give off little or no heat. Steam lines often create serious hazards of burns and are generally undesirable because of the heat which is dissipated from them. Furthermore, the exhaust of a steam engine is objectionable, especially in confined places, as in mines and buildings where suitable arrangements for exhaust cannot be easily made.

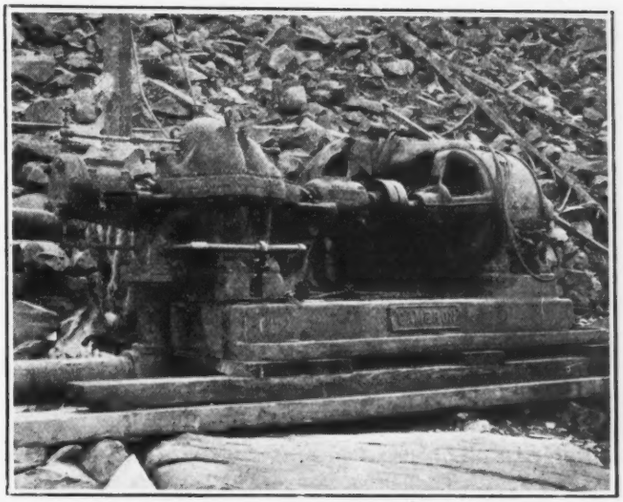

Fig. 3—Out in the weather day and night on the side hill of a rock pile, this two-stage, 40-hp. pump must resist weather conditions. It is used by the Sand & Gravel Co. of White Haven, Pa.

The unlimited portability of electrically driven pumps is another advantage over other types of drives. A pump mounted on a truck or on skids may be placed in service wherever a small power cable can be set up or laid out on the floor to feed it. Thus in development work an electrically driven pump is of extreme utility, as it can be moved from place to place without regard for pipe fittings such as are necessary for steam- or air-driven units.

Electrically driven pumps are compact and smaller than outfits equipped with other types of drives. For this reason they can be placed where steam- or air-driven units would require much work to provide sufficient space. Often the higher cost of excavating or otherwise providing a larger size housing for air- or steam-operated pumps represents a big item of expense, which is greatly reduced by use of the compact, electrically driven pumping outfit.

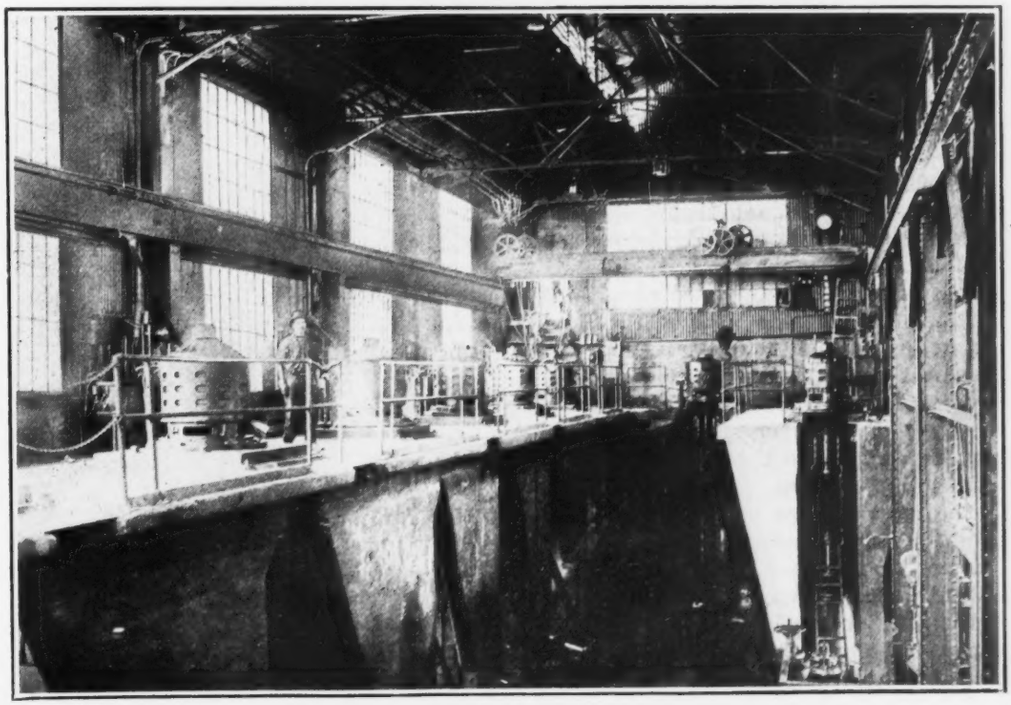

Fig. 4—These motors, driving fluid-circulating pumps at the leaching plant of the Chile Exploration Co., Chile, South America, are placed where direct splashes cannot get to them. They are 200-hp. 500-volt squirrel-cage vertical-induction motors

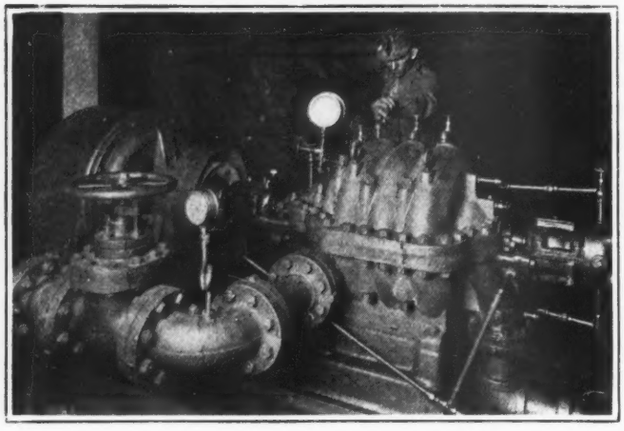

Fig. 5—An all-bronze four-stage centrifugal pump was selected by the Tennessee Copper Co. for this job. Needless to say that the necessity for an all-bronze pump suggests the motor must be kept dry from the acidulous mine water. The pump is designed for 425 gal. per minute against a 761-ft. head

The selection of the most suitable type of motor to drive a pump depends upon many things. Only after due consideration has been given to all factors affecting the successful operation of the pump should it be made.

The first consideration is often the load. Generally speaking, large pumps should be driven by alternating-current motors. Today the original form of electrical energy in large quantities is alternating current. If an alternating-current motor is used practically any convenient voltage can be selected for the drive and there are no power conversion losses. Transformers can readily be used to step down high economic transmission voltages to any desired potential required by an alternating-current motor.

If a direct-current motor is used to drive a pump the voltage of the distributing line and motor are the same unless resort is made to the unusual practice of using a direct-current to direct-current motor-generator set. Another disadvantage of the direct-current motor is the conversion losses which must be stood when the original source of the energy is alternating current. Greater reliability is always obtained by eliminating the rotary converter or motor-generator set and using an alternating-current motor.

Frequently when a direct-current pump motor is used it is supplied from a circuit furnishing energy to other direct-current loads, and disturbances such as overloads and short-circuits on these drives cause delays and troubles with the pumping equipment. Then again, pumps must often be operated when the other apparatus may be shut down, but because the pump must run the converting equipment must be kept in operation and thus cause high power conversion losses.

Of course, even after all these factors are considered, the type of pump or surrounding conditions may or may not determine the kind of electrical energy best suited for the drive.

The most popular types of motors are suitable for ordinary pump motor requirements, but for mining service it is very necessary that the motor be well protected and insulated to withstand moisture, acids, alkalies, dust, and dirt. For exceptionally bad service conditions motors having well-impregnated windings, drip covers, or inclosed frames are desirable.

The special conditions under which electric pump motors are used in the mining industry may be listed as follows:

1. Erosive dusts and dirt.
2. Strong acid or alkali moisture and fumes.
3. Steam vapor or extreme moisture.
4. Room temperatures higher than 40 deg. C. (104 deg. F.) or below 0 deg. C. (32 deg. F.).

Where dust and dirt are present, motors are at a disadvantage unless protected or specially designed for use under such conditions. Standard-type motors may be inclosed in boxes to exclude much dirt and dust, but they must then be aerated. They cannot dissipate heat so readily when the air around them is confined, and therefore should not be worked to their full load capacity. None but fully protected motors should be used where a spark might cause a fire or an explosion. Carbon dust or other metallic dusts all tend to break down insulation; hence motors should not be installed under conditions where such dusts are present unless protective features are incorporated in their design.

Strong acid or alkali fumes eat into insulation, cause corrosion, and otherwise shorten the life of motors. To combat them special insulating and protective varnishes are used on windings and metallic parts. Ventilating air is also furnished through tubes connecting the motor openings with a good supply of fresh air.

Steam and moisture tend to break down insulation and create rust, which pinches the insulation of windings and swells the conductors out of position. Protection should be provided for such motors by inserting a baffle to prevent splashes of water getting on the windings. Inclosed-type motors should be used where the amount of moisture reaching the motor is excessive.

Extreme cold interferes with lubrication; high temperatures cause overheating. It is always advisable to conduct cool, fresh air to motors working in warm and hot rooms, because unless this is done the internal heat of the windings is not properly dissipated and the insulation will become brittle and result in a failure.

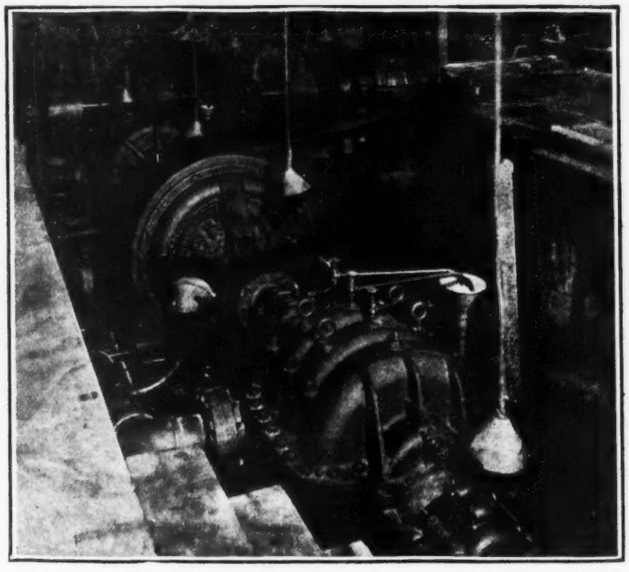

Fig. 6—Difficult operating problems must be met inside the mines. These two pumps are installed in a submerged pit in a pump room at the Hecla mine, Burke, Idaho. The pump in the foreground is a 600-gal. per-minute unit pumping against a 1,254-ft. head

Ores of the Joplin Region (Picher District)

By J. E. Spurr

IN APRIL of 1926 I spent several days in the district centered around Joplin, Mo., and had the benefit of the constant association and guidance of Mr. H. A. Buehler, State Geologist, and of Mr. C. E. Siebenthal, geologist of the U. S. Geological Survey, both of whom have given the district long study. I had also the advantage of the guidance of several mining engineers of the district, so that the most favorable conditions were present for seeing much in a short time. I am taking the liberty of presenting some notes derived from my brief sojourn, as above indicated, given with the full understanding of the sketchy nature of my visit. The interested reader should study the careful and valuable literature of the district, which covers many features which I have not touched upon: my contribution being somewhat in the form of a running comment.

The ores are in flat-lying Carboniferous limestones, with associated shales and cherty beds; and the proved ore district is more than 20 miles in its largest diameter.[1] The district lies at the junction of the states of Missouri, Oklahoma, and Kansas. The general trend of the ore district is east-northeast, corresponding with the predominant direction of the ore runs: this belt starts northeast of Joplin and runs through the corner of Missouri (Joplin and other districts) to Kansas (Baxter Springs and other districts) and on to Pitcher and other districts in Oklahoma (Fig. 1).

The local geological section is shown in the accompanying figure (Fig. 2), from the Joplin folio of Smith and Siebenthal (p. 3, Fig. 3). The chief ore horizon is at or near the top of the Boone limestone and chert, and at or near the under contact of the Cherokee shales.[2] There has been little development below this horizon, although locally drill holes have shown sparse ore minerals in lower formations, such as the Jefferson City (Ordovician) limestone.

Below the Boone limestone is a shale—the North View shale—not shown in the accompanying section. Artesian water under pressure underlies this shale.

I will first record some notes from my underground trips:

In the Broomcorn shaft of the Wilbur mine the following time succession was recognized: 1, limestone and sedimentary white chert; 2, dense jasperoid, very low grade as ore, with a little blende visible under lens; 3, jasperoid and blende, the latter more abundant than in (2); 4, solid blende. Afterward there was much movement, and open spaces were formed, which were lined with calcite; and there was, finally, a little chalcopyrite. This represents the usual age of the chalcopyrite. The ore zone is 10 to 20 ft. high, between almost unbroken floor and roof, but shows repeated movement and brecciation—probably due to the effect of leaching solutions and settling in the oreshoot alone.

[1]Dr. Buehler calls my attention to the circumstance that in a larger sense the ore-bearing district extends from near Springfield, Mo., to within 5 miles of Miami, Okla., a full 100 miles "The cross diameter from Waco on the north to Granby on the south is almost 40 miles. Within this area the deposits are typical and must be included."

[2]Dr. Buehler comments on this (having read the manuscript): "The sheet ground in Missouri, the Netta and all deep mines in Picher, the sheet ground at Baxter Springs, all lie as close or closer to the Northview than the Cherokee shale."

At the Kropp mine (Oklahoma) the time succession is simple: 1, the original sedimentary limestone and chert; 2, jasperoid and disseminated blende; 3, the most important stage—nearly pure blende. Above the main

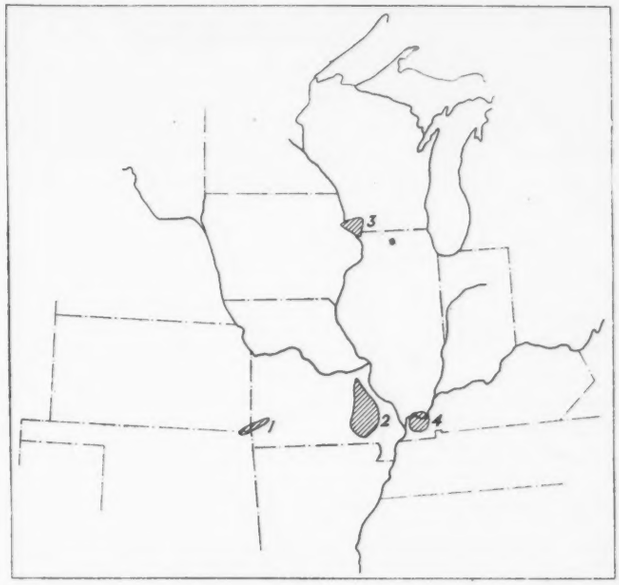

Fig. 1—Outline map, showing location of the Joplin region (1) with relation to the Southeast Missouri district (2), the Upper Mississippi district (3), and the Illinois-Kentucky district (4)

blende ore, in the stoping faces seen, was blende and calcite, and in the roof, coarse galena; and finally, in the roof also, open horizontal fissures ("crevices"). Further settling has resulted in bouldery ground above, which is post-mineral, since it affects barren limestone between the "runs" of ore. This barren limestone shows the original sedimentary chert, but not the jasperoid, blende nor calcite, showing that all these stages resulted from one solution. The ore "runs" in this mine have rather sharp boundaries, on top, bottom, and sides: in the roof are definite fractures running more or less in the direction of the shoot below. The brecciation is largely confined to the runs and is not notably shown in the barren limestone on the same horizon as the ore. This shows that the brecciation and movement was largely due to: 1, crosscutting steep fractures; 2, movements resulting from progressive shrinkages.

The ordinary blende ore at this mine contains practically no galena.

In the Gray Goose mine, near Picher, Okla., there is medium-grained blende mixed with calcite, inclosing angular fragments of jasperoid. Later fissures and vugs, some very large, are lined with fine calcite crystals. This ore is 85 ft. high; on top of it all is thin-bedded shaly limestone with horizontal coarse galena seams between the shale layers; also open vugs lined with coarse galena. The sequence here I took to be: 1, the original limestone and (white) sedimentary chert; 2, dark-blue flinty jasperoid, carrying fine disseminated blende in the later stages: this includes angular fragments of the white original chert, having evidently

replaced the limestone after the beds had undergone a preliminary shattering; 3, medium-grained aggregates of calcite and blende, inclosing angular fragments of (1) and (2); 4, calcite and galena in veins and vugs.

At the Hartley mine, at Baxter Springs, Kan., the ore is blende with a little galena, the ratio of zinc to lead being ordinarily about 100 to 1. The ore occurs in various horizons from the oölite member down to and a little below the Grand Falls chert. The limestone and chert shows evidence of having been crushed and shattered; and was penetrated by solutions containing silica and zinc which replaced the limestone and the chert, resulting in gray jasperoid carrying disseminated blende. Angular fragments of gray chert in this jasperoidal ore have been bleached along margins, and also along crosscutting fissures, evidently by the effect of the solutions.

Later than this important period of replacement and blende deposition was the lining of vugs, in this older deposit, with calcite and crystalline sphalerite, together with some galena and pyrite or marcasite. There was evidently much shrinkage attending this process, resulting in collapse and the tumbling together of boulders with the following down, into the collapsed area, of the Cherokee shale above.

At the Netta mine, at Picher, Okla., the last process observed at the Hartley mine—the formation in open vugs of coarse sulphides and calcite, which at the Hartley was of slight quantitative importance—forms the most abundant ore, consisting of crystalline coarse blende and calcite, and some galena. Angular fragments of jasperoid and limestone in this ore show a first deposit (ring) of calcite, surrounded by a coarse deposition of sulphides. Galena and blende are intercrystallized, but the deposition of galena overlaps that of blende, so that

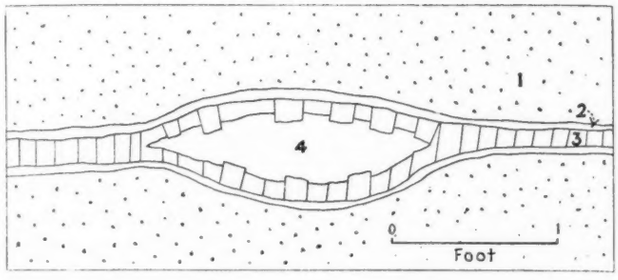

Fig. 3—Sketch of large vug in new Chicago mine, near Picher, Okla. (Joplin region), showing late occurrence of galena. By J. E. Spurr

1. Zinc blende, mainly formed by replacement of limestone. 2. Pink calcite, first deposition on the walls of a fissure in zinc ore. 3. Coarse galena, which has crystallized in an open fissure. 4. Open (residual) vug lined with large galena crystals up to 4 in. in diameter.

it is in part later. All this ore seems to have crystallized free in open spaces: it is confined to one limestone horizon, not far from the horizon of the Grand Falls chert.

At the New Chicago mine, at Picher, there is extensive ore in the oölite horizon, also in a cherty horizon some 30 ft. higher. The lower horizon shows alternating cherty and limy layers. Certain beds have been brecciated, leaving angular fragments of chert in crushed limestone which has been locally extensively altered to blende and jasperoid. The later stage of deposition is shown in irregular as well as bedded veinlets and vugs, which shoot all through the earlier chert, jasperoid, and blende. The lead is confined to the later deposition, which is so abundant that the mine produces more lead than zinc, the ratio being 2 or 3 to 1. Veinlets of the second deposition (here most important quan-

System.	Series.	Formation Name.	Symbol.	Columnar Section.	Thickness in Feet	Character of Rocks.
CARBONIFEROUS	PENNSYLVANIAN	Cherokee formation.	Cck		150+	Drab to black shale and gray to buff sandstone with occasional beds of coal.
		—UNCONFORMITY—				
		Carterville formation.	Cc		0–50	Light to dark shales and shaly and oolitic limestones with some massive soft to hard sandstones.
		—UNCONFORMITY—				
	MISSISSIPPIAN	(Short Creek oolite member.)			(2–8)	Massive homogeneous bed of oolitic limestone.
		Boone formation.	Cb		140–485	Limestone, in large part crystalline, with interbedded chert.
		(Grand Falls chert member.)	(Cgf)		(15–120)	Heavy-bedded, solid chert

Fig. 2—Geological column in Joplin region. From Joplin Folio of Smith and Siebenthal (U. S. Geological Survey).

titatively) consist of a first lining of calcite, and a filling of coarse galena. Where the fissure widens out, there is the same succession, but the center is open, as a vug, lined with large galena crystals, which must have formed in a volatile or fluid solution which filled the cavity, and is now removed (Fig. 3). Surely the supply of galena was a limited and temporary one.

The roof of the upper horizon is a definite shaly limestone layer, unreplaced, a circumstance suggesting ascending solutions.

The Bluebird mine and No. 8 shaft of the Shorthorn mine, which were briefly visited, are near the extreme western end of the mining area in Oklahoma. The ore occurs immediately below the Cherokee shale; the lower contact of the shale with the limestone below is some 190 ft. below the surface. The ore occurs in definite runs, shaped like bars of square cross-section, which step down one from the other, with steeply dipping

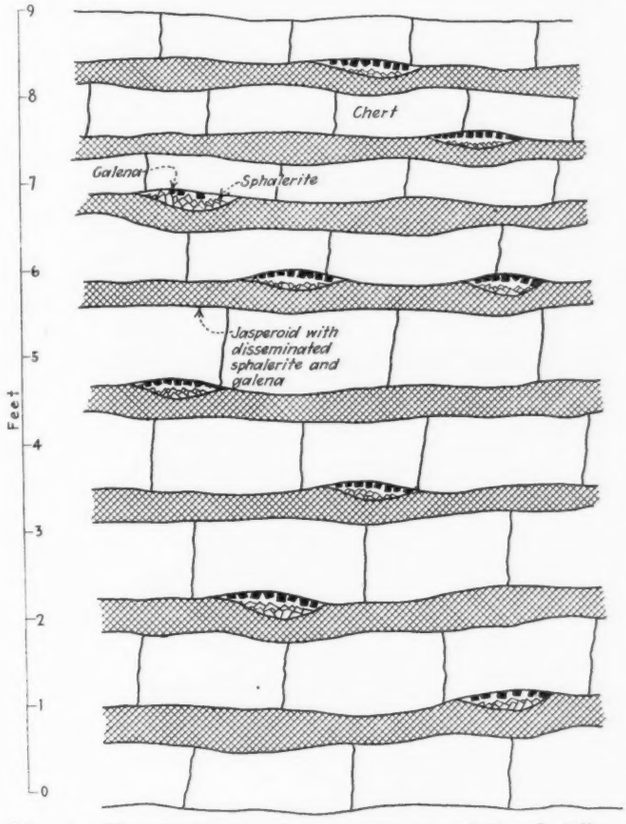

Fig. 4—Sketch illustrating occurrence of "pockets" or cavities in the sheet ground and the relation of galena and sphalerite to the cavities. After Siebenthal: Bulletin 606, U. S. Geological Survey, p. 235

sulphide stringers connecting them. The runs themselves are controlled by steeply dipping fractures, as is recognized by the miners. These mines are representative of a large group of so-called narrow-run mines, which are often small. In the larger mines the ore tends to broaden along favorable horizons, and unite fissure fields.

In this mine, galena ore was noted directly under the capping Cherokee shale; according to the superintendent, the galena is almost always at the top of the ore, also at the sides of the runs; outside of the galena, it was stated, iron sulphide comes.

From the above observations and other sources, including a study of the literature, and from the information supplied me by the geologists and engineers who accompanied me, I get the following as my own preliminary picture of the ore deposition: The ore solutions gained access to the rocks through a definite system of east-northeast and north-northwest fractures and fracture zones, the two sets being at right angles (Fig. 6). They were ascending under pressure (although the indications are that they traveled far laterally), and so, flooding this system of breaks, they rose mainly to the upper part of the cherty limestone horizon, between the North View shale below and the Cherokee shale above. They were definitely stopped in all cases in their upward movement by the Cherokee shale, below which they were localized, spreading out to varying degrees along favorable horizons. Such favorable horizons seem to have been especially the cherty ones, which on account of being brittle, offered at once, as a result of the fracturing which preceded the advent of the ore solutions, a greater openness. Since the amount and continuity of cherty layers in these horizons is variable, they localized in the first instance the access of ore solutions to a varying degree. Moreover, an old erosion surface at the base of the Cherokee had produced a layer of fragmental residual chert, and made this horizon an especially open and favorable one.

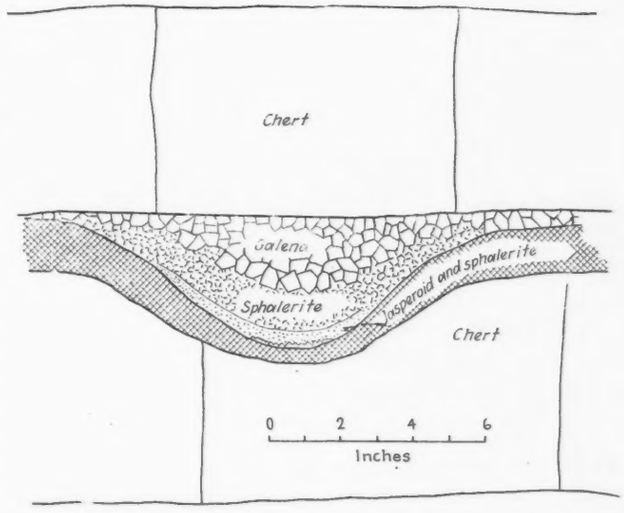

Fig. 5—Section of a cavity in sheet ground, at the Underwriter Land Co.'s Yellow Dog mine, Webb City, Mo. After Siebenthal, Bulletin 606, U. S. Geological Survey, p. 236

The first effect of the ore solutions appears to have been silicification, followed soon by contemporaneous blende deposition.[3] The silicification and the blende deposition were by replacement, and changes in bulk at once began to occur, which caused movements within the "runs" (simple or tied together along favorable horizons), in which the solutions stood under pressure. Diminution of bulk, apparently due to solution (of lime) exceeding precipitation (of silica and blende), seems to have begun, and through this and other forces, among

[3]In the case of fissure veins, especially quartz veins, I have shown that in the ore magma which filled them, the metallic minerals (principally sulphides) show themselves to have been characteristically more fluid than the silicates or other earthy gangue material, so that the metallic minerals often tend to crystallize later (where crystallization is sufficiently leisurely), in rifts in the vein gangue, in the wall rocks, or in subsequent cracks or slight fissures which affect the partly formed vein or the adjacent rocks. "Geology Applied to Mining." Revised edition, 1926, pp. 323-28. Where such an ore solution spreads out in limestone and siliceous beds, as at Joplin, the same succession seems to occur.

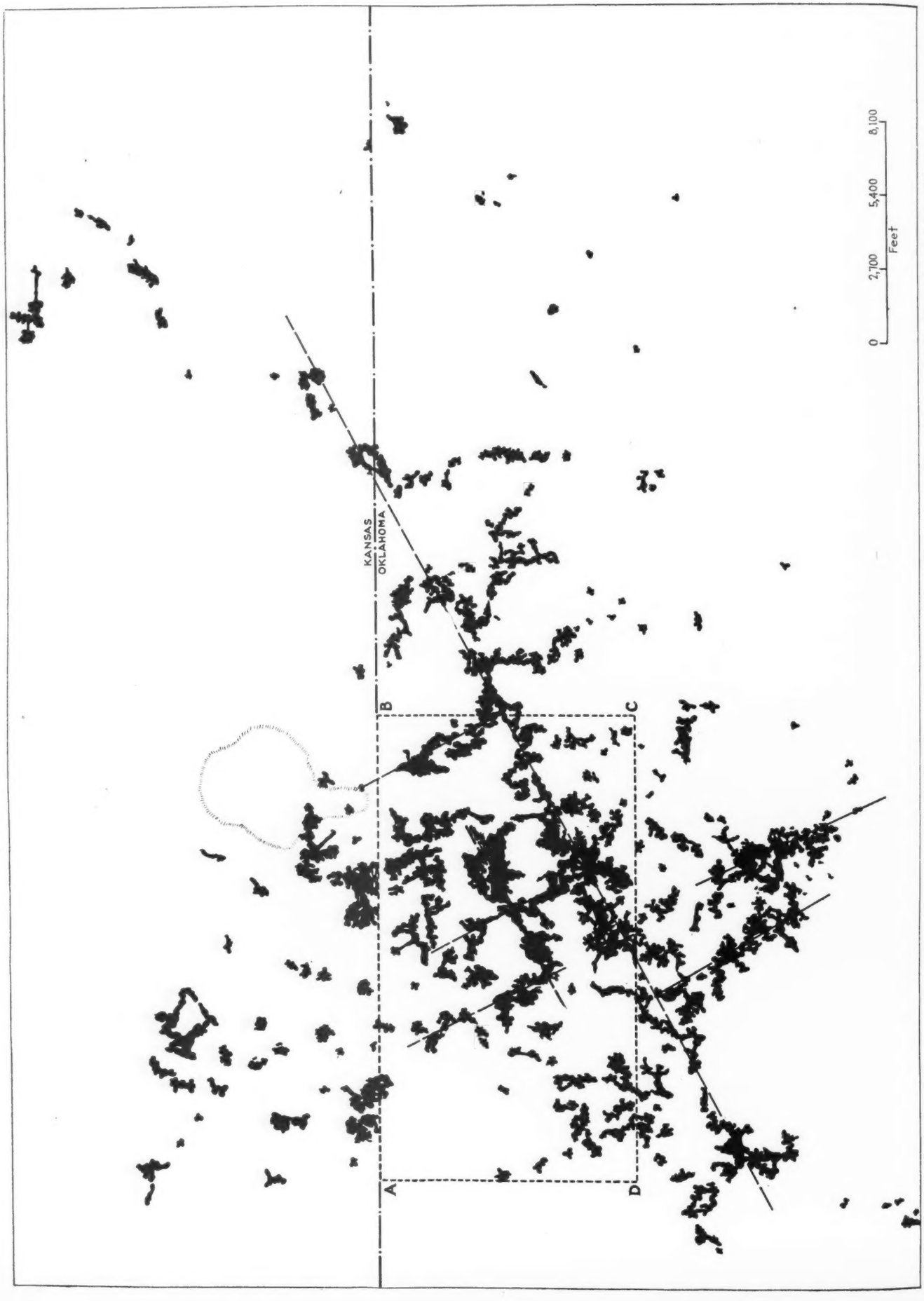

Fig. 6.—Developed orebodies in Kansas-Oklahoma lead and zinc field (Joplin region). Stewart & Schink, January, 1925. Shows

which may have been the pressure of solutions, breccias were formed, in which the brittle chert was moved about in the limestone, which was "working" under the processes suggested. Sagging of the "runs" and suffused beds created openings which began to form as the process of deposition passed from predominating silica to predominating blende: by the time that definite short fissures, crevices, and vugs were thus formed, the silica of the solution had been thrown down and the metals were in calcareous solution, the lime of which might well have been derived from the interchange. From such solutions, standing in open cavities, the calcite was either precipitated intercrystallized with the blende, or there was a first precipitate of calcite, lining the cavity, and a later precipitate of pure sulphide. During this stage of deposition in irregular openings the galena began to crystallize out, at first intercrystallized with the blende. Contraction and sagging, producing new openings, continued, so that later openings, formed particularly on top of the growing orebody, and to a less degree at the margins (both indicating progressive shrinkage)[4] contained predominating galena, or finally, galena only. Where the tops of such orebodies have been removed by erosion, and only the ore around the margins left, sometimes nearly circular rings of ore ("circle deposits") survive.[5] There was little or no replacement during this mainly cavity-filling stage, which was nevertheless an important stage quantitatively. At the close of the galena deposition there were still openings unfilled, which still remain as empty vugs of considerable size.

That silica, zinc, and lead were precipitated successively from the same solutions, and were not successive introductions and injections, is shown by the usual definite confining of all three to the same definitely limited orebodies. The natural degree of wandering and local concentration of the later lead-rich solutions is indicated by the considerably varying proportions of lead and zinc in the different mines, and in different parts of the same mine—notably in the tops of the "runs" and to a lesser degree on the edges.

Such a regular sequence indicates heated solutions, which cooled *in situ* after injection—solutions from which, in accordance with the well-established Zonal Theory, zinc crystallized first, and lead later, with the lowering of the temperature. Pronounced vertical zoning was prevented by the impervious Cherokee shale above, which limited the natural ascending tendency of the residual lead solutions, which eventually banked beneath it and formed the rich galena ores which so frequently occur just under this contact.

There is no evidence of more than one period of injection, or of the access of fresh supplies during the rather protracted orderly cooling period. The evidence is that the ore solutions came in at a single gush. The protracted deposition indicates that the rocks possessed a considerable temperature of their own—which they lost slowly. Had the rocks been cooler, crystallization of the whole ore solution would have taken place more rapidly and we should have had the typical complex lead-zinc ore, without the rude vertical zoning which exists, and, to be sure, without the coarse and often striking crystallization of the sulphides, particularly the galena. Finally the history outlined implies that the solutions were relatively concentrated, though certainly containing a considerable proportion of aqueous and other volatile materials. The widespread replacement of limestone to dolomite within the general limits of the orebodies shows also that the solutions were magnesian.

Such a type of mineralization is, of course, typically magmatic.

In offering this explanation I am not unmindful of the evidence offered by the recent formation of blende crystals on old picks, spikes, and drills, in closed mines, which had been left under water. My explanation is based on the primary ores, such as the type of the Bluebird, where the top of the ore is beneath 190 ft. of shale, and where there has been no oxidation. The phenomena of the recent secondary sulphides described occurred, as I understand it, in the older mines, where the shale had been eroded, as is the case over a large part of the Tri-State district, and where the usual processes of oxidation by atmospheric waters take place. Under such conditions, zinc goes into solution more readily than lead, and is carried downward as sulphate to the sulphide zone, where under reducing influences it may be reprecipitated as sulphide (blende). Such a reducing agent is metallic iron, upon which most of this recent secondary blende reported has been deposited: in some cases it is reported that the iron itself has been entirely corroded and has disappeared, leaving only the characteristic shape of the tool as a mold, showing that the oxygen of the zinc sulphate was combined with the iron. Such a process, however, is not one of nature, but of the class of laboratory reactions: It is similar to the well-known process of depositing native copper from mine waters by scrap iron, a process which evidently is not duplicated in nature. In general the zinc sulphate solutions react with limestone or calcite to form carbonate, or with silica in siliceous rocks to form silicate, these two being the common forms of secondary zinc. Doubtless also a certain amount of secondary zinc sulphide, and certainly more of lead sulphide, has been deposited by the descending atmospheric waters by more natural reactions: but these have probably been insignificant, if indeed present at all, in the key regions where no surface alteration has taken place, such as in mines of the Bluebird type.

The general occurrence of galena above blende has been described fully by Siebenthal.[6] He refers to the conclusion of Buckley and Buehler[7] that this is evidence of the precipitation of the primary sulphides by descending surface waters, in the Granby area of Missouri, which is an integral part of the Tri-State district now under discussion. Siebenthal points out that this general succession is not an entirely regular one, and that in some mines zinc ores were found to overlie the lead ores; indeed, that many individual orebodies form exception to the general rule.[5] And in connection with this vertical arrangement Siebenthal records a significant phenomenon which I did not note in my hasty trip—namely, that, in some portions of the region at least, even in small cavities, some not more than a few inches high, the galena in many cases is found next the roof, the sphalerite next the bottom. This he believes to rep-

Fig. 6—Developed orebodies in Kansas-Oklahoma lead and zinc field (Joplin region). Stewart & Schink, January, 1925. Shows tendency of ore to follow northeast and northwest lines. Rectangle A B C D shows area of Siebenthal map, Fig. 7.

[4]This manuscript was written before the publication (*Economic Geology* of August, 1926) of Augustus Locke's paper on "Mineralization Stoping" in which similar processes of cavity-forming by progressive shrinkage are described.

[5]Joplin Folio, p. 15.

[6]Bull. 606, U.S.G.S., 1915, pp. 229.

[7]Missouri Bureau of Geology and Mines, 2d ser., Vol. 4, pp. 97-98, 1906.

[5]*Op. cit.*, p. 229.

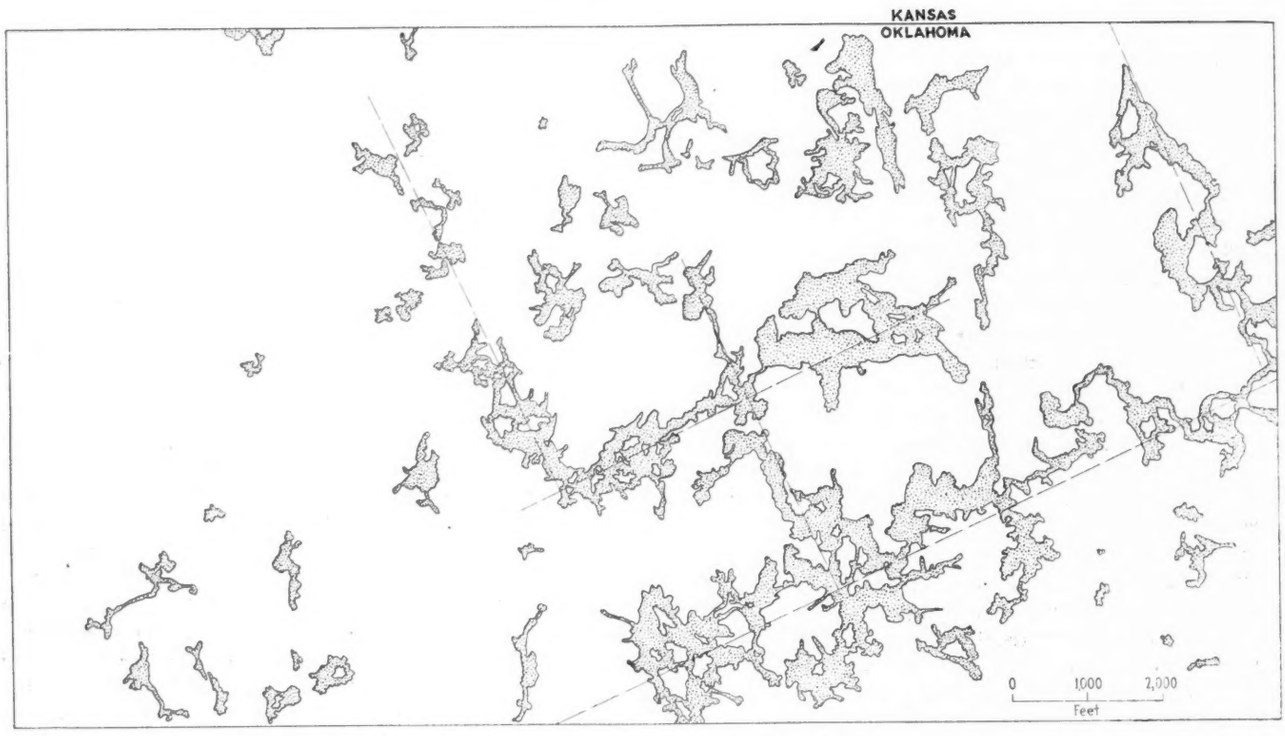

Fig. 7—Map of Picher district, Oklahoma (Joplin region), showing developed orebodies. Note the definite rectilinear trends, of which there are two chief systems, at right angles. Map covers same area as Figs. 8 and 9. Adapted from map by Siebenthal, U. S. Geological Survey

resent primary, not secondary, deposition (Figs. 4 and 5, Siebenthal, pp. 235, 236). Both galena and blende in these deposits may be found incrusted with marcasite, perhaps a secondary sulphide (J.E.S.) deposited by atmospheric waters.[9] Also in the deposits where sulphides have filled the openings between broken slabs and boulders of rock, the galena is reported as clinging to the under surface of slabs, while the sphalerite occurs some little distance below, the two being separated by gangue material. Such occurrences have also been described, in Missouri mines of the Tri-State district, by W. T. Smith[10] and by Buckley and Buehler.[11] Siebenthal notes that at Miami, Okla. (a part of the Tri-State district), where the uneroded Cherokee shale still covers the orebodies and there have been no secondary ores formed, the same general arrangement of sphalerite and galena in cavities holds; and concludes therefore that this arrangement has been due to the primary deposition by the ascending solutions which he believes to have been the agents of primary ore-introduction. His final conclusion is that "the vertical relations exhibited by galena and sphalerite when they arrange themselves in a cavity as in the sheet ground, or a large cavernous opening filled with breccia as in the open ground, is a molecular phenomenon, a manifestation of the inherent molecular activities of these two minerals."

Agreeing, as I do, with Siebenthal's conclusions that the primary ores (which, where unaltered, are practically as high grade as the oxidized and associated subjacent sulphide ores which occur elsewhere) were deposited by ascending solutions (as is proven, above all, by their banking up beneath the impervious Cherokee shale, in those areas where the shale has not been removed by erosion, and occupying the same horizon where the shale has been eroded and left the ores outcropping); and accepting his descriptions of the relations of galena and blende in small and larger vug and cavity fillings of primary nature: I wish to offer a definite, even if novel, hypothesis of explanation. The phenomena described just above are unusual: I do not remember to have remarked them elsewhere, nor does Siebenthal cite similar occurrences elsewhere. They are therefore due to unusual local conditions at the time of deposition: if they were due to "inherent molecular activities" between galena and blende the phenomenon should be of widespread occurrence.

And in this connection there is another phenomenon which was impressive to me on my brief visit, since I had never seen it so prominent elsewhere. At the Bluebird, in the Oklahoma section of the Tri-State district, the ore is limited above, at a depth of 190 ft., by the Cherokee shale, which extends from there to the surface. Galena occurs in fissure veinlets all through the cherty limestone immediately beneath the shale. This is the general occurrence of galena, according to the foreman—at the top, and also at the sides of ore "runs." But what attracted my attention to these mines as a most unusual phenomenon, in the stopes which had the Cherokee shale as a roof, was the abundant bitumen which has dripped down from the shale into the stopes. This type of occurrence has been fully described by Siebenthal,[12] as occurring over a wide area in this vicinity—in the Oklahoma section of the Tri-State district, where the Cherokee shale has not been eroded. This bitumen, he records "is closely associated with the ores"[13] and is in considerable amount. He interprets

[9] *Op. cit.*, p. 237.
[10] Joplin Folio, U.S.G.S., (No. 148), 1907, p. 17.
[11] *Op. cit.*, p. 60.
[12] *Op. cit.*, p. 205.
[13] *Op. cit.*, p. 206.

it as the residue of an oil (petroleum) carried by ascending solutions, which oil "lost the lighter saturated hydrocarbons by fractionation in contact with shale.[14] The fact that this residue was left at the base of the shale indicates that the lighter hydrocarbons escaped upwards."[15] Siebenthal considers that the petroleum was carried by the ore solutions.

Accepting all these conclusions, I suggest that the vertical arrangement in closed cavities, described by Siebenthal, was due to the process known to modern hydrometallurgy as oil flotation, a process the operation and efficiency of which is so well known that I will not discuss it here, nor yet the obscure physical laws which control it. In the separation of finely ground galena from blende, by the commercial flotation processes, the heavier galena floats, buoyed up by oil; the lighter blende, less capable of being filmed by oil, sinks. The air bubbles which are active in the commercial process certainly may have been well represented by any free gas in the fluid ore solutions. The process as suggested is indeed a form of gaseous transfer, but a mechanical instead of chemical one, the mechanism being made possible by the presence of petroleum in the ore solution. An objection which at once presents itself is that sulphide flotation is operative on solid particles, not on solutions. Examining this, I note Siebenthal's conclusions, which are undeniable, that the separation of galena and blende in question took place in stagnant solutions filling cavities.[16]

A corollary from the consideration of the cavities figured by Siebenthal leads to the conclusion, which he does not emphasize, that the solutions must have been relatively concentrated, a conclusion certainly resulting from my own observations. Slow crystallization such as I have inferred (p. 202) from such a solution would result in tiny crystals appearing in the solution, either of blende first and galena afterward, or possibly of both nearly together. The hydrocarbons present would, according to my suggestion, attach themselves to the galena particles and float them to the roof, thus securing a stratification of galena over blende, in the early stage of crystallization, which would be accentuated later. Mass action would complete the work, attracting the lead from the mixed solution preferentially to the growing "slush" of galena above. Flotation is efficient in proportion as the size of the solid particles decreases.[17] Petroleum is commercially used as a flotation agent.[18] Such a separation might even take place in the colloidal state, or in that state where the colloidal state passes over into the suspension of fine crystalline particles."

August 11, 1926.

Since writing the above I have completed my paper on the Southeastern Missouri district, and the comparison brings out more strongly the points of difference between that and the Joplin region, which I noted in that paper.[20] I am not referring to the relative proportions of lead and zinc in the two districts, which I regard as a slight difference. In both regions the chief lead-zinc ores are replacement shoots in limestone, following certain favorable horizons, and both due, by my analysis, to ascending solutions. The course of oreshoots (mainly horizontal) in the flat-lying strata, in both, is evidently largely controlled by fracture systems of slight or no displacement. But the internal structure of the orebodies is entirely different, and the differences may throw additional light on the original nature

[14] *Op. cit.*, p. 16.
[15] *Op. cit.*, p. 16.
[16] *Op. cit.*, p. 241.
[17] A. W. Fahrenwald: Pamphlet No. 2, Idaho Bureau of Mines and Geology, 1921, p. 7.
[18] Richards and Locke: "Ore Dressing," 1925, p. 273.
[19] Richards and Locke: *Op. cit.*, p. 269.
[20] *Engineering and Mining Journal*, Vol. 122, No. 24, Dec. 11, 1926.

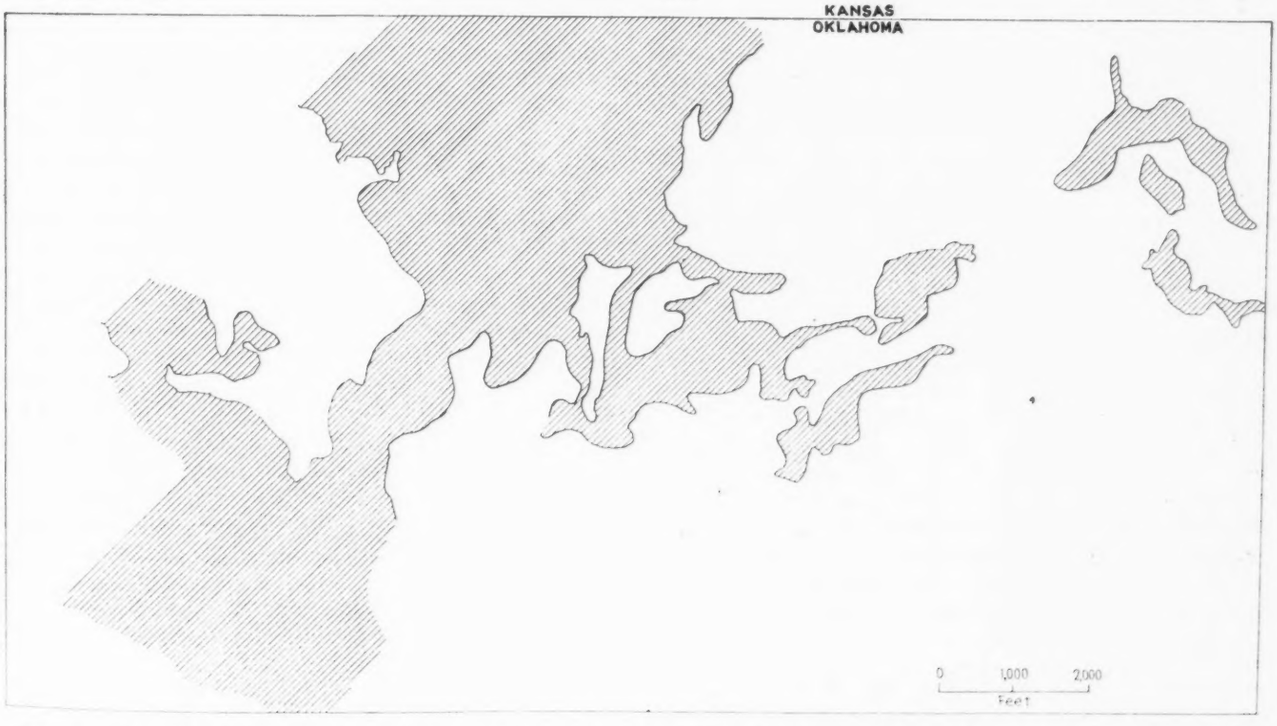

Fig. 8—Map of Picher district, Oklahoma, showing base of Cherokee shale where this comes below the 750-ft. contour. Adapted from map by Siebenthal, U. S. Geological Survey. Heavy line is 750-ft. contour; shaded area is shale below this level

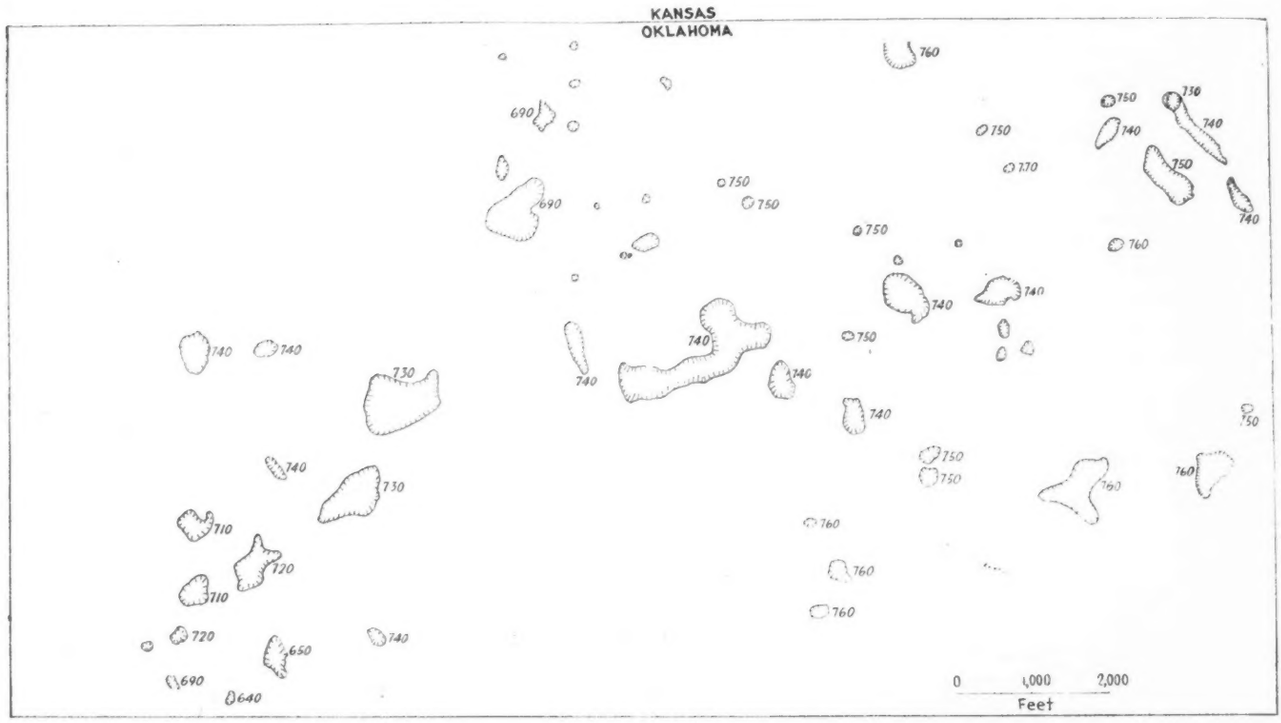

Fig. 9—Map of Picher district, Oklahoma, showing margins of abrupt depressions or sink holes. Outer line of each is base of Cherokee shale at the numbered contour. Covers same area as Fig. 6. Adapted from map by Siebenthal, U. S. Geological Survey

of the ore solutions in both districts. The phenomena and internal structure of the ore in the Joplin region is complex: in the Southeastern region relatively simple. To the phenomena at the latter, many striking ones have been superadded in the Joplin region. They are, as above indicated:

1. Intense and repeated brecciation, due to
   a. Repeated collapse of the roof above the channel occupied by the ore solution during the process of ore crystallization.
   b. Probably the expansion pressure of the ore solutions.
2. The position of much of the ore in open cavities.
3. Presence of residual vugs and caves in large amount; once filled with residual water or gas, or both.
4. Stratified arrangement of galena and blende, the former uppermost, which took place repeatedly as successively created openings were occupied and partially filled by the ore solutions.
5. The presence of abundant bitumen, indicating the former presence of much petroleum, closely associated with or mingled with the ore solutions.

Not only are these Joplin region phenomena all entirely lacking at Flat River, in Southeast Missouri, but their prominence is remarkable and unusual in the Joplin region as compared with other lead-zinc replacements in other states and countries. Some of these phenomena are shown, indeed, in other and more remote districts in the United States and elsewhere; but they are rather the exception, while conditions like those at Flat River represent perhaps the norm.

The significance of the last two of these aberrant phenomena I have already discussed—the stratified arrangement of galena and blende, and the presence of abundant bitumen: and suggested an hypothesis. The first three of the points above stated may also be considered as a group, evidently all indicating a relatively thin ore fluid—not an extremely concentrated and dense ore solution. This fluid abstracted, from the moment of its introduction, more material than it replaced: while it doubtless pressed upward against the overlying Cherokee shale roof of the main ore horizon (since it was this roof which impeded further upward passage), it was incompetent to support this roof, which collapsed repeatedly; and this shrinkage and collapse is not only indicated for the main roof, but for the various larger solution-filled cavities in the forming orebody, below the roof. When most of the mineralization was finished, many vugs and caves were left, into which great crystals slowly grew, indicating that the residual cavities were filled with a very dilute fluid—probably water. The indications, in short, are that the ore solutions were distinctly aqueous, although a fairly well concentrated aqueous solution: nevertheless that they were injected at a definite period (as is shown by their progressive change in nature after introduction) and did not represent a sustained circulation. The early silicification which changed later to the deposition of calcite, and the general subsequence of galena to blende, also indicates heated solutions—corresponding perhaps with the usual temperature for the deposition of galena-blende ores.

The conclusions as to the significance of the group of the first three erratic phenomena noted may now be considered together with the last two, and we find that the main difference between the ore solutions at Joplin and at Flat River consists in the addition of petroleum and water to the former. In nature, as we know, petroleum and (salt) waters are closely associated. This suggests to me that the typical zinc-lead ore magma or solution at Joplin and the rest of the adjacent region met and mingled with petroleum and water coming from a different source.

There is still another striking phenomenon in the Joplin region which is entirely absent at Flat River and neighboring deposits—the important early silicification. In my papers on the Kentucky-Illinois field and on the Southeast Missouri field, I accepted this lack as normal, for the indications are that the ore deposits there are derived from a subjacent basic magma mass, and basic magmas and the associated ore deposits are normally poor in silica. Silicification—the production of jasperoid by replacement of limestone—is, to be sure, a familiar feature in connection with lead-zinc deposits, as at Aspen in Colorado, at Bisbee in Arizona, and many other camps: but in these cases the apparent magmatic association is with intermediate magmas, not distinctly basic ones. I assume that the Joplin region ores are magmatic—having assumed that for the Kentucky-Illinois field (an assumption which is quite generally acknowledged) and for the Southeast Missouri field (which I have shown is closely similar in its proofs of magmatic origin to the Kentucky-Illinois field), it is impossible not to extend this assumption to the other ores in and on the flanks of the Ozark uplift. It is indeed principally by this analogy that we must arrive at this conclusion. The usual (though not invariable) concomitants of magmatic ore districts are in the Joplin region suppressed—there are no igneous intrusions, dome structures, nor any but minor faults.

Assuming the magmatic derivation, the distinctive silicification of the Joplin region, as compared with the other fields previously described, may be due to derivation from a more siliceous magma, or it may be due to silica introduced into the mixed ore solution postulated at Joplin, in the waters with which it became combined. In this connection I refer to my notes on the barite deposits of Southeastern Missouri, in my paper on that district.[21] Abundant silica was deposited earlier than the barite and with it, constituting a marked exception to the normal Southeast Missouri ore deposits; cavities of dissolution were formed in the limestone before the ore deposition, and cavities remained open at the close; and the main silicification preceded the barite (and lead-zinc) deposition. In all these ways there is an analogy with Joplin. I suggested in the case of the barite deposits that waters, very likely of non-magmatic origin, had mingled with the ore magmas in this case; and had been responsible for the early dissolution and silicification. Such waters in the Joplin case must have been ascending, because they were confined, like the ore solutions, beneath the Cherokee shale; and in so far I am in accord witih the conclusions of Siebenthal.

Not all of the conspicuous brecciation in the Tri-State district was due to caving: much of it cannot be ascribed to this. It may frequently be observed, for example, that a solid bed of limestone only a few feet thick has been shattered and the fragments moved about, while the beds above and below are undisturbed. Differential movement of bed on bed is suggested, and this was probably one factor; but when it is found that the brecciation does not extend beyond the oreshoot horizontally into the same strata, this hypothesis is seriously attacked. I have been unable, finally, to account for some of the brecciation except by an expanding effect of the penetrating ore solutions—a conclusion which would harmonize with the expansion of gases, experiencing relief of pressure on arriving in the relatively open space and higher horizon afforded by the ore "runs." For such an expanding fluid or gas we do not have to seek further than heated water, expanding under relief of pressure, or becoming temporarily hotter in contact with or by reaction with ore magma; and probably carbon dioxide. It is possible, moreover, that water acted as a precipitant of the metallic sulphides, a suggestion which I have also made in the case of the barite (lead-zinc) deposits of Southeast Missouri.

If these comparisons lead to the above assumptions, to explain the marked dif-

[21] *Engineering and Mining Journal*, Vol. 122, No. 24, Dec. 11, 1926.

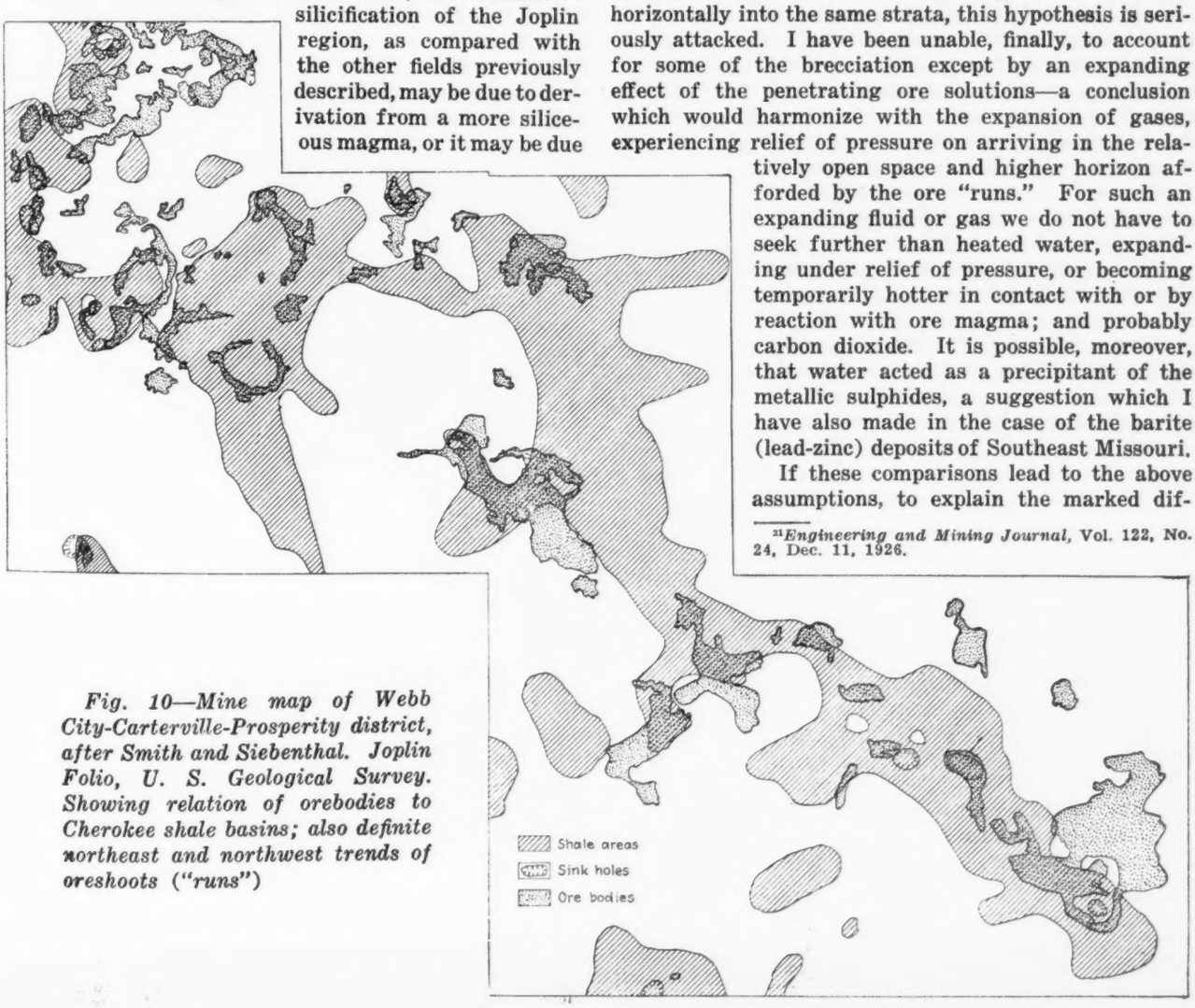

Fig. 10—Mine map of Webb City-Carterville-Prosperity district, after Smith and Siebenthal. Joplin Folio, U. S. Geological Survey. Showing relation of orebodies to Cherokee shale basins; also definite northeast and northwest trends of oreshoots ("runs")

ferences of ore-deposit structure and attendant phenomena at Joplin as compared to Flat River, their absence at Flat River emphasizes conclusions which I have already included in my paper on the Southeastern Missouri district: that there is no evidence of water in the solution from which these ores were deposited, or indeed that they contained anything of importance except the fluid sulphides and possibly such a solvent (as Freeman has supposed) as alkaline sulphides. Contact of such a solution with a little water would cause precipitation, as Freeman has shown experimentally. The marked influence of shaly beds in causing precipitation, throughout all of this Southeast Missouri region, may indeed be due to the fact that the shale beds are naturally preferential water-carriers, above or below.

While the contrast in conditions and structure between the Tri-State district and the Southeastern Missouri district is striking, as above pointed out, there is a strong resemblance between the Joplin and the Upper Mississippi or Wisconsin-Illinois ore district, which district I have earlier described.[22] In both these districts the horizontal strata are practically without important faulting:[23] there are no igneous intrusions: and the ore has been deposited to a considerable extent in openings as well as by replacement. In both these districts there are shallow synclinal depressions in a shale horizon, which have been thought by some geologists and miners to have partly determined the locus of ore. For the Upper Mississippi district I have already discussed this.[24] For the Picher district in Oklahoma, which is a part of the Joplin region, a map has been published by Siebenthal showing the orebodies and the sub-shale (Cherokee) contours, and suggesting to the reader to study it and form his own conclusions as to the relation of the two. I have done so, and find them in general quite independent of each other. Locally the subsidence by shrinkage of an orebody has produced some concordance. Therefore in the detailed mine maps shown in the Joplin folio of the U. S. Geological Survey (No. 146, by Smith and Siebenthal) there is a close but still not absolute connection. For such connection as there is, in both the Joplin and the Upper Mississippi regions, I am inclined not to believe that the depression has been responsible for the location of ore. but the reverse—that the slumpage of the orebodies during deposition, above discussed, has largely caused the depressions. This is apparently in line with the opinions of Smith and Siebenthal as to the formation of the shale synclines. (Joplin folio, p. 10.) In Southeast Missouri, where there have been no open spaces developed during ore deposition, and consequently no slumpage, these slight synclinal basins, and their relation to the ores, have not been described, and apparently do not exist.

For purposes of better comparison I have dissected this valuable map of Siebenthal into three parts: 1, the orebodies as mined (Fig. 7); 2, the shale below the 750-ft. contour (Fig. 8), this being taken as the best one to show the relative shale depression; 3, the sink holes or abrupt depressions, as mapped by Siebenthal (Fig. 9); only those showing a relative depression of 20 ft. or more have been included. These maps are shown respectively in Figs. 7, 8, and 9. Comparison of these three maps leads at once to certain general conclusions: 1, the ore tends to occur in belts along straight lines, in two systems of right angles to one another, indicating control of ore introduction by fractures due to regional (dynamic) fracturing; 2, there is no general relation between ore belts and depressed shale areas; 3, there is no general relation between ore belts and sink holes; 4, there is a general relation between broad depressed shale areas (Fig. 8) and sink holes (Fig. 9).

Even where at first there seems a coincidence between orebodies, synclinal shale basins, and sink holes, as is the fact locally, especially at the Hunt mine, in the extreme northeast corner of the map, the shale basins and sink holes have a tendency to occur, not so much directly over the orebody as definitely to one side and parallel with it. Many of the most abrupt sink holes occur immediately adjacent to an orebody, but not in it nor over it. Such sink holes evidently belong to the period of solution and caving which was later than the ore, such as I noted underground in the Kropp mine (p. 199).

From an inspection of mine workings underground only, the relative importance of this post-mineral solution and caving, as compared with the subsidence during ore deposition, could not be evaluated; but these maps, based upon drilling the whole area, immediately show this post-mineral slumping to be of much greater volume than the mineral-period slumping: and indeed that the marked sink holes of the mapped region in general are due to this process. And since these sink holes are in general situated within broader areas of shale depression (Fig. 8), it seems to follow that these broad depressions must be in part, and even possibly to a major degree, due to such a post-mineral solution process.

There will be noted, in the western part of the area mapped, a broad area of shale depression which extends north-northeast irregularly clear across the map, not in the least parallel to the east-northeasterly trend of ore belts. The sink holes within this area align themselves roughly in a similar north-northeasterly direction, indicating underground circulation system (of water) independent of the orebelts and subsequent to ore deposition.

These relations being established, the question comes up how much of the slumpage directly over the orebodies, in those parts in the Joplin region where there is an evident relation between depressed shale basins and sink holes on the one hand and orebodies on the other, is due to this post-mineral underground water circulation and solution. It is evident that much of it may be due to this: and the fact that the regions of such evident close relation (as in the mines described in the Joplin folio of Smith and Siebenthal) (Fig. 10) are in a section where older strata lie nearer the surface, so that the shale (and probably much of the ore) has been eroded away except for these inlying basins, strengthens this impression. So far, then, as these basins and sink holes have furnished an argument for a sink-hole or "Karst" topography in the Boone limestone surface on which the Cherokee shale was laid down in Carboniferous time, the evidence of such a topography is eliminated.[25] Moreover, the great length

[22] *Engineering and Mining Journal*, Vol. 117, Nos. 6 and 7, Feb. 9 and 16, 1924.

[23] The largest faults in the Joplin region have a displacement of 25-35 feet, and are post-mineral. (Joplin folio, p. 9.)

[24] *Engineering and Mining Journal*, Vol. 6, No. 117, Feb. 9, 1924, p. 250.

[25] I do not mean this to imply that I consider this single bit of evidence as sufficient to decide the question of the "Karst" topography. I am in fact not in a position to give an opinion concerning this matter, which has been studied carefully by various geologists, to whose published reports I refer the reader.

of time which must have been necessary for the formation of this extensive system of post-mineral sink holes and solution-synclinal basins of shale, through waters circulating beneath the shale (during all which time there has been no sign of ore deposition) bespeaks the origin of the ores as due to some cause other than water circulation, present or in the past, artesian or descending. It has been noted by Smith and Siebenthal[26] that the fissures and fractures which were post-Mississippian are those occupied by the ores and gangue; but that "the joints and fissures resulting from the much later Lafayette elevation are largely open or filled with uncemented crushed chert. They cut across the ore horizons of the sheet ground and therefore are of later age." This observation indicates the period of ore deposition as later than the Carboniferous, since the ores have been deposited under the Pennsylvanian (Cherokee) shale; and earlier than the Lafayette, which is of mid-Tertiary age.

The ores of the Joplin region are in the Carboniferous limestones and shales, or at the same general horizon as those of the Kentucky-Illinois district, whereas those of the Upper Mississippi district are in Ordovician limestones and shales; but this does not in the least interfere with the correlation of the Joplin region and Upper Mississippi fields. Too much has been made by geologists of the age of the limestone in which the ore locally occurs, in the various Mississippi lead-zinc districts. The various limestones, of whatever age or horizon, are simply host rocks; the ores were introduced long after all of them were deposited, and probably at the close of the Cretaceous, as discussed for the Kentucky-Illinois district and the Southeastern Missouri district.

[26]Joplin folio, U. S. G. S., p. 8.

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By E. P. Mathewson

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Costs of Gold Recovery Declining in Ontario

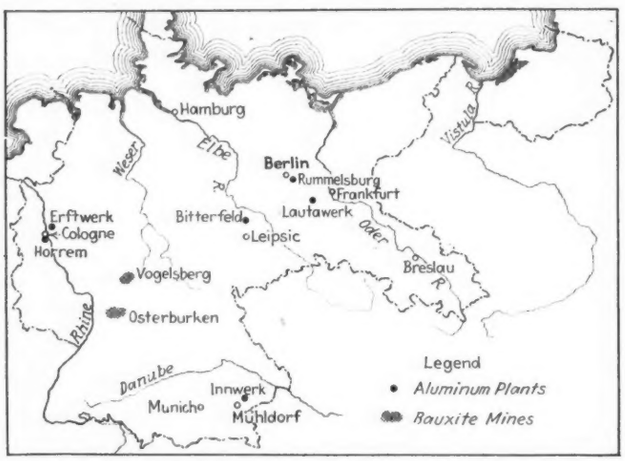
A noteworthy phase of the mining situation in the gold districts of northern Ontario is the general war on costs, says *The Canadian Mining Journal*. In the Porcupine and Kirkland districts operating efficiency has attained the highest pitch so far on record. A favorable feature is that the era of declining costs appears to have only begun, and that as years go by the tendency will be still lower. Whereas average costs in 1925 were about $5 per ton (including depreciation), it is evident that average costs by the end of 1928 will be possibly $3.50 per ton. Hollinger, for instance, is expected to reduce costs eventually to an average of not more than $3 per ton. This means that all the rock containing $3 to $5 per ton in gold will become profitable ore and will add millions of dollars to the resources of the mines.

Germany Well Equipped to Produce Aluminum

Existing Plants Have Nominal Capacity of Over 43,000 Tons of Metal Annually—Now Seeking Independence From Foreign Ore Monopolies

ONE OF THE SURVIVING EFFECTS of the Great War has been its far-reaching influence on the development of the electrochemical and electrometallurgical industries, one of the most important of which is the production of metallic aluminum. Before 1914 Germany was a heavy importer of the metal, the only producing plant within her borders being that of the Aluminium Industrie Aktien Gesellschaft Neuhausen, situated at Rheinfelden, near Basle, and yielding 800 to 1,000 metric tons per annum. This plant operates by water power, but the Rhine being here an international stream, further extension has been impossible.

In the ten years from 1915 to 1925 six plants for aluminum production were built and operated in Germany. Of these two smaller and less efficient have been closed down and one has been diverted to other uses, leaving three of the largest and most modern factories in the world, which are operated under a consolidation



Sketch map of Germany, showing the location of aluminum plants and bauxite mines

known as the Vereinigte Aluminium Werke, with a productive capacity of more than 30,000 tons per year. Following are particulars of the works operated in Germany since 1915:

Table I—Aluminum Producing Plants in Germany

Location	Near	Started	Closed	Capacity, Kilowatts	Capacity, Metric Tons
Rummelsburg	Berlin	1915	1923	10,000	3,000
Horrem	Cologne	1916	1921	10,000	3,000
Bitterfeld	Leipsic	1916	1925	12,000	3,500
Erft	Grevenbroich	1916	Operating	48,000	15,000
Lauta	Hoyerswerda	1918	Operating	20,000	6,000
Toging	Muhldorf	1925	Operating	42,000	12,000

The plants at Rummelsburg, Horrem, and Bitterfeld were started up by the Chemische-Fabrik Griesheim Elektron assisted by the German Government. Rummelsburg was connected with the Oberspree Power House, operating on braunkohl. The Horrem and Bitterfeld plants were also operated with electric power generated from braunkohl steam plants. It will be noted that none of these three plants is now operating. The Bitterfeld factory was started for the production of aluminum of specially high purity, but when the modern and economical factories were in operation this plant was closed. Although its capacity was nearly 4,000 tons per year, not more than 1,000 tons was ever produced. The Erftwerk was built on an entirely new program at the time when the production of aluminum on a very large scale was deemed essential for war purposes; it was initiated by the Giulini company and the Rhenische Westfalische Electrizitatswerk with the assistance of the German Government. The Lauta factory was started by the Metallbank and the Toging plant owed its inception to the Siemens Schückert and Giulini companies. After the beginning of operation these three factories were consolidated under the name of Vereinigte Aluminium Werke. This concern has a nominal capital of 21,000,000 gold marks, but the principal stockholder is the German Government through the holding company, the Vereinigte Industrie Unternehmungen A. G.

The production capacities listed in Table I are only nominal. They represent the electrical equipment installed and are subject to a strict limitation in connection with supplies of raw material. The available bauxite in Germany is confined to the deposits in the Vogelsgebirge district of Hesse, where the mines are producing at the rate of 1,200 tons per month. It is reported that this production can be doubled. However, this amount is obviously insufficient to supply the three large aluminum plants in Germany with material for more than 10 per cent of their production even if the quality is sufficiently high. A good grade of metallurgical bauxite should have not less than 55 per cent Al_2O_3 and not more than 2 per cent SiO_2. On this basis the Hesse ores are low in alumina and high in silica.

During the latter part of the war large stocks of bauxite were shipped to Germany from the Adriatic provinces of Austria, and for a considerable time after the armistice the plants were operated on this material. After the Versailles Treaty these provinces became Italian and a large proportion of their ore continued to be exported to Germany. The average monthly imports of bauxite into Germany amount to 20,000 tons, chiefly from Italian sources. There are indications, however, that this material is being diverted to uses in Italy, and the tonnage exported will probably diminish. The French bauxite field has also furnished a large portion of the supplies for Germany, but the tendency here also is to restrict exports. Bauxite ore from Dalmatia in Jugoslavia has also been extensively used, but is not of the most satisfactory quality, because of its hardness and relatively low solubility.

The most promising bauxite deposits at present are those in the Bihar district of western Rumania, where, it is estimated, the supplies are not less than 20,000,000 tons. Purity and physical quality are both satisfactory. Evidently there is considerable competition to block out and acquire deposits in this region, both the German and the Swiss interests being represented. The Rumanian Government, however, is evidently inclined to foster aluminum production within its borders and may probably take steps to conserve its bauxite

deposits. Recently the Vereinigte Aluminium Werke has acquired valuable and extensive deposits of ore in eastern Hungary near the Rumanian border. The deposits are estimated at 30,000,000 tons, and bauxite from this source is beginning to replace Istrian and French bauxite in the German industry.

Experimentation is now going forward with a view to utilizing lower grades of bauxite and kaolin to render the aluminum producers independent of the foreign bauxite monopolies.

Bauxite is refined to alumina by removing the organic impurities, water and ferrous compounds. A well-established industry is that of the Curtius A. G., of Duisburg, where a considerable tonnage of alumina is produced from German ores. Two other well-known refining plants are those of the Martinwerk A. G., near Neuhausen, and the Geb. Giulini at Ludwigshafen; both are situated in Switzerland, but have exported much of their ore to Germany. The Lauta plant of the Vereinigte Aluminium Werke has its own refining factory, which also serves other works in the same group. For many years the Bayer process has been used. This method of refining employs sodium hydrate and high-pressure steam to decompose the bauxite, after which it is filtered and the insoluble iron and titanium and silica oxides are removed. Aluminum hydrate is deposited from the sodium aluminate solution by introduction of a small quantity of alumina and by agitation. The precipitate is thickened, washed, and calcined, becoming anhydrous alumina.

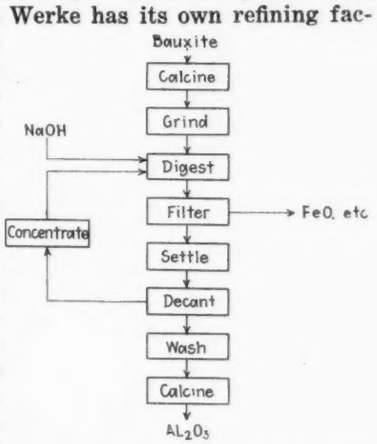


Fig. 1—Diagram showing steps in Bayer process for making alumina

New processes have been devised for the refining of lower-grade ores and kaolin, usually with a by-product in view. One of the most promising of these methods, which is already in successful use in Germany, is the Haglund process, in which bauxite is smelted electrically with carbon and pyrites, the resulting slag containing mixed aluminum oxide and sulphide, which can be tapped and separated on crystallization. The slag is then crushed and leached with water (releasing hydrogen bisulphide, which can be regained), concentrated, dried, and calcined, and is then available for electrolysis. The chief merit of the process is the reduction in the fusing point of aluminum oxide brought about by the presence of 15 to 25 per cent aluminum sulphide. This makes it possible to liquefy and tap off the slag without decomposition of Al_2O_3 and the formation of carbides.

Methods have been devised to eliminate bauxite by reducing kaolin or some other aluminous clay, of which there are many deposits in Germany. In the process of Berger and Kuhne, kaolin and iron pyrites are crushed and heated in a reverberatory with magnesium chloride and a proportion of iron filings. Aluminum chloride distills over and is condensed afterwards, being electrolyzed in a bath of sodium and potassium chlorides.

Of the three great production plants of the Vereinigte Aluminium Werke, the first is that originally established by the Erftwerk A. G. on the Erft at Grevenbroich, not far from Dusseldorf. This factory was designed during war time on a heroic scale and has never been operated at full capacity. It consists of an electric substation, electrolytic plant, and carbon electrode factory. Power is furnished from the system of the Rhenische Westfalische Electrizitatswerk over three 110,000-volt transmission lines terminating in three 30,000 kva. banks of step-down transformers. The secondaries of the transformers feed fifteen rotary converters, each of 4,000 kw. Allowing for spare plant, there is available 48,000 kw. of direct current at 350 volts.

There are twelve furnace rooms, each being fed from one converter through a 12,000-ampere bus. When operating at full load the capacity of the entire factory will be not less than 14,000 tons per annum. Since the energy has to be purchased, however, it has not been found economical in peace time to work this plant at more than half load, and there is a tendency at present to restrict production still further. In addition, the Erftwerke possesses an up-to-date electrode factory, which furnishes all the anodes used by Vereinigte factories.

The Lauta plant, in the Lausitz region of Saxony, is more modern than the Erft. It has the advantage of being located in the vicinity of the Erika soft-coal mine controlled by the V. A. W. and possesses an up-to-date steam-electric power house generating direct current for the furnace rooms. Three furnace rooms, each with its own individual line of eighty pots, are fed from three groups of generators in the power house. The actual production at full capacity is 6,000 tons per annum, but extensions to the factory are in hand which will increase this figure. A short distance from the power house is the alumina-refining plant where the impurities are removed from the bauxite. This plant operates on the Bayer process and furnishes aluminum oxide to the other smelting works as well as to Lauta.

INNWERK IS EUROPE'S GREATEST WATER-POWER INSTALLATION

Lastly should be mentioned the Innwerk, which constitutes the greatest water-power installation in Europe. The plant is situated at Toging, near Muhldorf, in Bavaria, and utilizes the falls of the River Inn at Jettenbach. From the dam at this point 13 miles away the water is carried in a canal to Toging, where the 100-ft. head is utilized. The power house contains fifteen units, each rated at 6,300 kw. Of these generators eight furnish alternating current to the neighboring carbide factory and the seven others are direct-current generators supplying the aluminum works at 400 volts 15,000 amperes. Two of these machines are regarded as spares, leaving five generators, or approximately 32,000 kw., connected to the furnace rooms.

In the customary manner each generator feeds its own furnace line at 400 volts, the middle point of the series of 60 pots being grounded so that no bus line or terminal is more than 200 volts above ground. It will be seen that the normal capacity of this plant is about 11,000 tons of aluminum per year, given a continuous flow of water and continuous supply of raw materials. It is sometimes necessary to reduce the output of the Innwerk power house so as not to bring down the flow of the river below a prescribed minimum; however, it would in such a case be most expedient to reduce the output on the alternating-current

side, which would not affect the production of aluminum.

It will be seen that Germany is equipped at least as well as any other European country for the production of aluminum. Though the coal-fired steam plants are somewhat less economical than hydro-electric power, the latter is capable of development. According to some authorities there is from four to six million horsepower in water falls awaiting development and capable of utilization.

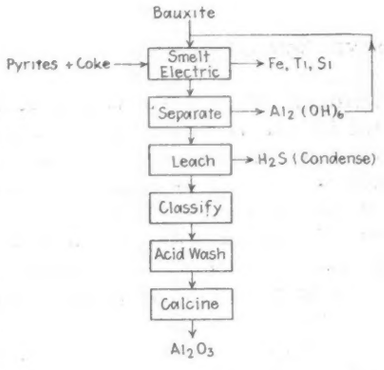


Fig. 2—Diagram showing steps in Haglund process for making alumina

Metallic Substitute for Diamonds in Core Drilling

Until recent years a drill set with small diamonds has been the standard equipment for core drilling, which is regarded as an essential process in modern prospecting and developing of ore deposits. During and since the war a good deal of research in Germany has been directed to the discovery of a metallic substistute for the diamond in core drilling, partly with a view to cheapening the operation, but also with the object of obtaining greater convenience in setting the crown of the drilling tool. In a recent issue of *Glückauf* is an interesting account of the results obtained in this research, and particulars are supplied in some detail of not fewer than eight different metallic substitutes for the diamond in core-drilling operations. Of these, two—volumit and thoran—practically equal the diamond in hardness. These are essentially carbides of certain metals. In volumit the metals are chromium, nickel, and tungsten chiefly, and in thoran the metals are thorium and tungsten. These are about equally hard, and possess the toughness of ordinary steel. They cannot be forged; it is necessary to cast them into the desired shape and to grind a cutting edge. The cost of these materials in drilling is stated to be a mere fraction of the cost of the diamonds consumed, and because of the standard shape and size of the cutting parts, the adjustment of them in the tool is simple and does not require the experienced and skillful work necessary in setting the practically spherical diamonds. The cost of drilling is about half that of the same work carried out by the use of the diamond.

Another type of metallic material is also valuable for the cutting parts of drilling tools—alloys of the stellite type, in which high percentages of cobalt figure, the other principal metals being chromium and tungsten. Though less hard than volumit and thoran, they can yet be used with great advantage in drilling through moderately hard rocks, and particularly in forming the cutting parts of drilling tools. They are also little affected by acid, alkaline waters, or salt solutions.

A feature of both the above-described types of material which gives them special value in drilling operations is that they retain their hardness and cutting properties at high temperatures such as are created by the action of the drilling tool in hard rock.

The Sunset Mine, in Washington*

Ore Has Been Developed to Depth of 600 Ft. and Is Still in Sight

By Nels E. Johanson

ON THE WESTERN SLOPE of the Cascade Mountains, about 40 miles east of Everett, Wash., is situated the Sunset mine. The district, about 100 square miles, includes some twenty-five mines or well-located prospects, of which the Ethel, the Copper Bell, or Bunker Hill, as it is now called, and the Sunset are the three largest and most important. Index and Baring, served by the main line of the Great Northern Railway, and Galena are the principal towns.

The Sunset property, the largest of the three and the only one in operation at present, is the one I have chosen to discuss. The mine is on Trout Creek, one mile from its junction with the north fork of the Skykomish River. It is reached from Index by means of a standard-gage logging road 5 miles long to Trout Creek, then by a series of three switchbacks to the mine, an additional distance of 2 miles.

The original location was made on the Sunset and the Black Bear claims on June 19, 1897, by Arthur C. Egbert, and the original Sunset Mining Co. was incorporated on July 8, 1897, by Ezra M. Egbert and Arthur C. Egbert. The property is now owned by the Sunset Copper Co., which holds thirty-six patented mining claims and 640 acres northeast of the mining claims. E. A. Sims is president and general manager, and Ed. C. Morse is superintendent. I am indebted to Mr. Morse for the opportunity of working at this property for a period of sixteen months, during which the data presented in this paper were assembled.

Orebody a Mineralized Shear Zone

The country rock is granodiorite, known as the Index granodiorite. About two miles up the creek east of the mine the granodiorite is in contact with the Gunn Peak formation, consisting of quartzites and intrusive dike rocks. Large boulders and float of quartzite, probably left there by a glacier, are found on the hillside north of the mine. All mine workings are in the granodiorite.

The orebody has been called by some a true fissure vein. It is, strictly speaking, not a true fissure vein, as there are no well-defined walls; rather there appears to be a mineralized shear zone. In some places both the footwall and the hanging wall are fairly regular, though at other points neither of the walls can be specifically defined. In many places small stringers of ore, sometimes high grade, branch off into the walls as shoots, and the wallrock itself may be highly impregnated with ore minerals. It is essentially a lode having stringers of ore through it; in some places the ore is widely disseminated throughout the gangue, and in others it is massive. Horses of granite are found between the masses of ore in some places.

The lode strikes N. 78 deg. W. and dips 80 deg. to the northeast. Along the strike of the lode the width of the vein varies from a few inches to as much as 20 ft. High-grade ore usually occurs in the narrow places, but it is too thin to work profitably. In the wide places, where the ore takes a kidney or lens form, mining has been carried on profitably. Up to the present three lenses or oreshoots have been worked. The oreshoots

*A paper read at the North Pacific Section Meeting, A.I.M.E Nov. 23, 1926.

are not distinctly separated, but are connected by narrow stringers of ore and crushed granodiorite in the shear zone, thus indicating a more or less continuous body. The lode line has been traced for a distance of nearly two miles. No prospecting has been done at the contact with the Gunn Peak formation. It would be interesting to discover what actually exists at that point.

The mineral making up the ore is principally chalcopyrite, with considerable bornite in places. The black oxide, tenorite, is found along the slip planes. Pyrite and marcasite also occur in a gangue of quartz, calcite, and altered granodiorite. Some native silver has been found near the surface. The chalcopyrite is undoubtedly primary, and was deposited by upward-trending mineral-bearing solutions. The bornite and small amounts of cuprite are possibly due to secondary enrichment by downward-percolating surface waters. Some of the bornite in the lower workings may possibly be primary. Chalcopyrite shows alteration to bornite, and bornite in many places replaces the biotite and hornblende of the granodiorite.

Other Veins Besides Sunset

The Sunset lode is the main orebody of the property. Another vein, the Harrington or the Little Copper King, has been stoped at two different places which were opened by crosscuts from the Sunset drift. These two stopes are apparently on the same vein, although they differ somewhat in strike. They also differ from the Sunset. The mine map indicates that these two veins may join several hundred feet west of the present workings. The vein designated as the Little Copper King is somewhat different in character from the Sunset. It is narrower, often as small as a few inches, and ranges from this up to 2 or even 4 ft. The ore is usually concentrated as a core along either wall and consists of massive chalcopyrite and bornite. Evidence points to a slight movement after the deposition of the ore, producing a soft gouge mass, which can be mined with a pick without the use of explosives. This movement also opened up the ground, permitting downward-percolating waters to leach the upper 200 ft. and enrich the zone below. The ore is partly oxidized even at depths of 600 ft. from the surface, making it difficult to treat by direct flotation, as is done with the sulphides of the Sunset. Consequently this vein is not now being worked, except by leasers, who sort and ship the best ore direct to the Tacoma smelter. This sorted ore averages about 15 per cent copper and carries low values in gold and silver.

Another vein, the Copper King, as distinguished from the Little Copper King, has a strong surface showing. A short tunnel cuts the vein 150 ft. from the surface. The ore shows well in this opening. The vein is also cut at a depth of 700 ft. by a long crosscut tunnel from the Sunset drift, but as yet has not developed ore averaging over 1 to 1½ per cent copper ore. The tunnel has not yet reached the point directly under the surface exposure. It is possible that this orebody may rake as do the shoots of the Sunset vein. Several small veins exist which cut across the main tunnels and crosscuts, one of which, the Blank, has a width of several feet and yields good assays.

The Sunset vein or lode, the main and the only one upon which extensive mining has been done, is opened 300 ft. below the outcrop at an elevation of 1,400 ft. by a rock tunnel, known as No. 2, 600 ft. long to a point where it cuts the Sunset vein. From the tunnel drifts are extended both southeast and northwest along the vein for several hundred feet. The main tunnel continues ahead for another 500 ft. to a point where it cuts the Little Copper King vein. Another tunnel, No. 1, is driven east of No. 2 at an elevation of 1,550 ft. and intersects the vein 150 ft. from the surface. No. 3 tunnel, above No. 2, cuts the vein at an elevation of 1,600 ft. and 100 ft. from the surface. Stoping has been carried down from this elevation to No. 1 level.

Several raises have been driven from No. 2 level to No. 1, providing means of ventilation and access to the ore. Raises have also been driven from No. 1 level to the surface. One stope which came to the surface has since been mined as a glory hole. From No. 2 level a winze has been sunk to a depth of 200 ft., giving two additional levels, No. 3 and No. 4. Raises have also been driven connecting levels 2 and 3 to block out the ore and provide ventilation. On No. 4 level a short drift has been driven, but no stoping has yet been done. This level is flooded at the present time. On it good assays and indications of ore were found. Levels 1, 2, and 3 have been worked extensively. The problem of mining has not been an easy one, as the ore is not uniformly distributed along the strike. This necessitates a great deal of prospecting, because of the spottiness, the number of cross fractures, and the stringers which lead off into the walls. It is an easy matter to go by, over, or under a good body of ore; hence it is necessary to search carefully and to have assays made frequently in order to plot the trend and value of a mass of ore. In stoping, the ore is followed closely, and the stopes are of odd and irregular shapes. Two methods of stoping are in use—timbered stopes and shrinkage stopes. The shrinkage method is used in ground which stands well and has fairly regular walls, and in places where the ore is of lower grade than the average mill heads. Timbered stopes are often extended into the rich part of the shoot, from which a shrinkage stope is mined on either end, thereby giving access to the shrinkage stopes without the necessity of raising and blocking out the ore. Only one man is required in each stope, and little powder is used in breaking down the ore. Consequently shrinkage stoping carried on in this manner is cheap and satisfactory.

The timbered stope operations are essentially a combined overhand and breast method, employing horizontal caps hitched into the footwall and supported on the hanging wall by posts. The caps are really stulls and are usually put in with headboards, thus allowing for any squeezing or swelling. The ground is not heavy, but large slabs of wall rock will swell, due to expansion in the fractures after they are exposed to the air. Posts are 7 ft. long; 8 by 8-in. timbers are used for caps; lagging is sawed 3 by 12 in. by 6 ft. long. The ore is shot directly onto the lagging and mucked into timbered chutes. Two full floors are carried the entire length of the stope, the mining floor and the mucking floor; the third floor down is pulled and used over again. Chutes are timbered and lagged, thus allowing the mined-out portion to be used for gobbing waste. This method is more expensive than shrinkage stoping. It is used where the ground is broken and fractured, where the ore must be carefully followed, and where the granite must be gobbed. The ore from the timbered stopes and the shrinkage stopes is mixed so as to produce a

mill head that ranges from 2.5 to 3 per cent copper.

Ore from No. 3 level is trammed and dumped into an ore pocket at the shaft and there hoisted to No. 2 level. Ore from No. 1 level is dumped into two transfer chutes to the No. 2 level, which is the main haulageway and which is on a level with the coarse-ore bunkers. All tramming on the 1 and 3 levels is done by hand in ¾-ton cars. From the shaft pocket and transfer chutes on No. 2 level the ore is taken to the coarse-ore bins by means of a gasoline locomotive which hauls four 1¼-ton cars, or 5 tons to the trip. Average production hauled to the mill is 100 tons per day.

The prevailing belief among mining men is that ore does not extend to depth in the Cascades. The Sunset has developed ore to a depth of 600 ft., and good ore is still in sight at this point. This fact should give encouragement to other mines and lead to further prospecting on the dip of the orebodies.

Ore Treated by Flotation

The process of milling the ore is comparatively simple, as the sulphides lend themselves readily to oil-froth flotation. The primary breaker at the mill is a 10x20-in. Blake crusher. This, together with a set of 16x36-in. Traylor rolls, comprises the coarse-crushing unit. The product of the jaw crusher is 1½ in. The rolls are set close and crush to approximately ⅜ in. At present a gyratory breaker is being installed between the jaw crusher and the rolls to increase the grinding capacity. The fine-crushing unit consists of a 6x5-ft. Allis-Chalmers ball granulator, and a 5x6 ft. Colorado Iron Works pebble mill. The product of the rolls is fed to the ball mill, which is run in closed circuit with a Dorr classifier, the oversize returning to the ball mill and the overflow passing to four Deister concentrating tables. Table concentrates are delivered to an Oliver filter, the middlings and tailings to a second Dorr classifier. Classifier oversize passes to the pebble mill, with which it is in closed circuit; fines go to the flotation unit.

The flotation unit consists of two Zeigler roughers, two K and K type tailings machines, and one Callow cleaner. The Zeigler tailings go to the K and K machines; the K and K tailings to the creek as waste. Froth from the Zeigler and the K and K machines is fed to the Callow cell. Callow cell tailings are returned in closed circuit to the Zeigler machines; the concentrates are partly dewatered in a Callow cone, then join the table concentrates for delivery to the Oliver filter. Mixing of the two concentrates has the effect of preventing choking of filter cloth. The filter cake drops to the storage bin.

Flotation reagents used are pine tar oil and xanthate. Two grades of pine-tar oil are used, and are mixed in different proportions, depending on the character of the ore. Xanthate was first tried in the system over a year ago. Although a little difficulty caused by the choking of the filter arose, the xanthate reduced the tenor of the tailings and it has been used ever since.

The grade of the table concentrates is about the same as that of the flotation concentrates. It varies between 30 and 35 per cent copper. This is a rather high-grade concentrate, but it is necessary to lessen the amount of material shipped to the smelter. The recovery is about 95 per cent on a feed averaging 2.5 per cent copper. Tailings will assay about 0.12 per cent copper.

The problem of transportation of the concentrates has been rather difficult. When logging was going on in the Trout Creek Valley, the logging trains brought railroad cars direct to the mine, and loading was a simple operation. At present the logging train brings the cars to the mouth of Trout Creek, two miles by rail from the mine. A Fordson tractor was rebuilt and equipped with a four-wheel drive mechanism which hauls five-ton cars equipped with regular-type railroad braking shoes. By this means two cars, or 10 tons, are taken down the hill on each trip. The maximum grade of the road is 12 per cent, with very sharp curves. Two trips can be made per day, or a total of 20 tons hauled. On the return trip supplies are taken up the hill. The transportation of men, mail, and light supplies is done by means of a gasoline speeder.

All mine timber is logged and sawed at the mine, costing about half of what it would if purchased. The blacksmith shop is located near the mouth of No. 2 tunnel. An oil furnace, Leyner No. 5 drill sharpener, coal forge, and all accessory tools comprise the equipment. Adjoining the mill is the machine shop, which is equipped with the machinery necessary for all repairs. On an elevated platform in the machine shop two air compressors are set. One is an Ingersoll-Rand, the other a Rand. Both are run by Pelton wheels bolted direct to the main cross-head shaft. Air is supplied at a pressure of 100 lb. The camp buildings consist of the usual type common to mine camps.

Power for all purposes except that of logging is supplied by water brought from Trout Creek by means of a flume about a mile long, which terminates in a penstock above the mill. A 24-in. compression pipe carries the water to the Pelton wheels, under a head of 200 ft. and a pressure of 85 to 90 lb. The Pelton wheels are direct-connected, except in the mill, where line and jackshafts are run from the main Pelton wheel. Plenty of water is always available for power except in the summer months of August and September. The lake at the head of Trout Creek has been developed for water storage by building a dam and putting in a siphon, which gives 20 ft. additional water in a lake covering 65 acres. This gives more than ample supply for the dry months. The maximum need of the mine is 20 second-feet.

It will be interesting to note the costs at the Sunset mine. For 1925, mining costs were about $2.25, milling costs were $0.90, and surface expense was $0.25, or a total of $3.40 per ton. The company has been very successful in operating on a small scale, and showed an operating profit at the end of the year.

Nitrate Process Based on Cold Leaching

The Coya Norte plant of the Anglo Chilean Consolidated Nitrate Corporation went into operation Nov. 22, 1926. This plant is designed to operate on the Guggenheim process for recovery of nitrate from caliche, which process is based on cold leaching accompanied by refrigeration of the solutions, in contrast to the older method of hot leaching. The caliche will be leached in large open vats of 7,000 tons' capacity. By the new method greatly increased recoveries and lower costs are expected.

A battery of six 100-B electric shovels has been installed as a substitute for the older hand method of mining the caliche. The capacity of the plant is reported to be approximately 500,000 tons of nitrate per year.

News of the Week

Summary

RECLAMATION WORK at Barnes-Hecker mine stopped; disaster costs company $500,000 in workmen's compensation — Michigan Governor favors research work.

Howey property, at Red Lake, Ont., financed by Hammell—Area and Amulet drilling results disappointing; stock prices drop.

Oddie stresses need of funds for Bureau of Mines—Low Moor Iron Co. liquidates—Gold mining at low ebb in Oregon.

Blue-sky law proposed for State of Washington—Joplin operators secure reduction in compensation insurance.

United Verde Extension enters Joplin district; also begins work on 2,000-ft. shaft in Bisbee (Arizona) district.

Shattuck-Denn continues development work on 1,900 level—Phelps Dodge sinking 2,500-ft. shaft; reverberatory plant at Douglas, Ariz., nears completion.

Golden Horseshoe issues statement on operations—Mexican Department of Mines reports increased productions despite new laws.

Panama Corporation still in prospecting stage—Gold concessions under development in Venezuela.

Livingston mine making regular shipments—Tonopah district shows slight improvement.

Hudson's Bay Co. sues Canadian Government for mineral rights in land grants.

New Lead-Silver-Gold Region in Alaska

BY CARL F. WITHAM
Chisana, Alaska

THE lead-silver-gold-bearing formation situated between the north slope of the Wrangell Mountains and the Alaska range, in the upper part of the Copper River valley, is composed principally of granite, diorite, and porphyry rocks, and as it is not well known it has not received the attention from prospectors and geologists that its importance as a mineral-bearing region seems to justify.

Several factors have retarded the exploration and prospecting of this region. In the early pioneer days, the country was difficult of access and transportation rates were so high that lode deposits, unless extremely high grade, could not be worked profitably.

The lead-silver-gold-bearing area is from four to twenty miles wide and is mineral bearing for over 150 miles in length. Its trend is east and west, and for the greater part of its length it forms a separate and distinct range of low hills, from 3,000 to 5,000 ft. in height. The lower slopes are covered to a considerable extent with soil and vegetation, which has made the prospectors' job more difficult.

Lead-silver outcrops are extremely plentiful over the region extending easterly for 25 miles from the Chistochina River, and occur over a zone four to five miles in width. I have examined fourteen veins in this section, varying from 18 in. to 10 ft. in width, which are highly mineralized with galena. A streak one foot wide of nearly solid galena ore was seen in one vein. Assay samples taken from the different veins gave in excess of 10 per cent lead and from a few ounces to as high as 42 oz. of silver per ton of ore. Galena is the principal valuable mineral, although a few veins contain some gray copper (tetrahedrite). Zinc is conspicuous by its absence. Some of these veins can be traced along their strike for a distance of over two miles.

Near the Nabesna River two granite-porphyry contact veins 16 in. wide carry a lead content of 14 to 31 per cent and a gold-silver value in excess of $20 per ton. On the Nabesna River a quartz vein 2½ to 4 ft. in width has lately been discovered, which carries values, mostly in gold. Specks of native gold are frequently seen in this ore. A few miles east of the Nabesna River is a large lead-silver-zinc deposit. It occupies a mineral zone 800 ft. wide and traceable for over 4,000 ft. in length. Samples taken across a 200-ft. width of this zone gave 5.27 per cent lead, 3.1 per cent zinc, and 6 oz. of silver, a total value of $16.57 per ton of ore. This mineral zone occupies a contact between a dark-colored igneous rock footwall and a massive limestone hanging wall. The zone itself has decomposed and weathered down on the surface and presents a striking color scheme of lemon, orange, and red. It is cut by several dikes of intruded dark porphyry, which stand up prominently.

An Alaska road in Upper Copper River valley

From the Chisana River easterly to the Canadian boundary line on the White River many lode deposits are known. Numerous small veins from a few inches to several feet in width contain good gold values.

An enormous tonnage of commercial ore can be developed easily in this district, and this tonnage will be greatly increased in volume by the development of the copper deposits in the adjacent foothills along the north slope of the Wrangell Mountains. The Nabesna Copper Corporation has installed a diamond drill on the Orange Hill property and will do considerable work there this coming summer. James J. Godfrey, who engineered the Mother Lode mine to production, gained lead mining experience in the silver-lead districts of Canada in his early career, is now developing lead-silver properties situated east of the Chistochina River, and also a lead-silver-zinc property near Nabesna River.

A government highway will be completed to the Chistochina River the coming season and will furnish a motor route from the Copper River and North Western Railroad at Chitina, to within

a few miles of the lead-silver fields, and it is intended to continue this highway eastward to the Canadian boundary line on the White River, there to connect with Canadian roads built from White Horse, Yukon Territory. This highway when completed will greatly facilitate the transport of supplies and ore and form an import route for Canadian ores to American smelters.

There are two available outlets for ore from this region, the cost of transportation being approximately the same for either route: one down the Copper River to Chitina and over the Copper River and North Western Railroad to Cordova and the other down the Tannana River by boat and over the Alaska Railroad to the Alaskan coast. The cost of freight transportation by mining companies in Alaska and the Yukon Territory situated fully as far from a railroad or steamboat shipping point as is this region is approximately $50 per ton of ore shipped from the mine to a smelter at either San Francisco or Kellogg, Idaho, smelter charges included.

U. V. X. Enters Mining of Zinc Ore in Missouri

The United Verde Extension Mining Co. has acquired, under purchase contract, a half interest in the Jasper Mining Co., which owns in fee 227 acres of land in Jasper County, Mo., about three miles from Joplin. Work done on these lands has disclosed a vein of ore 12 ft. thick for a distance of 1,500 ft.

The company is getting copper from its mine at Jerome, Ariz., and with the new acquisition will become a zinc producer. The entrance of the United Verde Extension Mining Co. into the zinc field may indicate that the company expects to manufacture brass.

Construction of a power line to furnish current for operations of United Verde Extension Mining Co.'s new shaft in Gold Gulch, in the Warren district of Arizona, has been started. Development work calls for the expenditure of approximately $200,000. Power will be furnished for operating the shaft through a 2,000-ft. line, connecting with the main line of the Phelps Dodge Corporation.

Utah, adjoining the Eureka Lilly mine of the Chief Consolidated Mining Co., and west of the Tintic Standard mine. Inasmuch as no other large orebody except that of the Tintic Standard has been found in the East Tintic district, unusual significance is attached to this development in the Eureka Lilly.

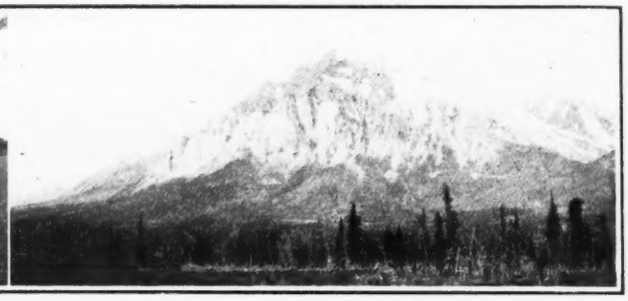
Another consideration also serves to increase the importance of the discovery. Several years ago, after a careful geological study of the district by Paul Billingsley, chief geologist of the International Smelting Co., diamond-drilling operations were begun, and the existence, below the rhyolite flow, of the Ophir limestones block-faulted down into a quartzite trough was proved, a condition analogous to that believed to determine the deposition in the Tintic Standard.

Drifting from the 700 level of the No. 2 shaft of the Tintic Standard was begun. By using a mechanical mucker and working three shifts daily this heading has been pushed ahead 150 to 200 ft. per week. In crossing the narrow strip of Eureka Lilly ground, a body of milling ore was exposed for a distance of 40 ft.

Less than a week after the first strike of milling ore was made 99 ft. of ore was exposed and 200 tons of ore produced from straight development work. Utah mining men regard the International Smelting Co.'s discovery in North Lilly ground as one of the most important developments in the last decade of Utah mining.

An average sample taken every 5 ft. of the last 40 ft. assayed $2.20 in gold and 13 oz. of silver to the ton, and 16.5 per cent lead. By sorting, it is believed the grade can be raised to 30 per cent lead. The mineralized area is intensely shattered. In the brecciated body of replaced Ophir limestone, boulders of galena and anglesite are found. A considerable proportion of the ore is carbonate.

An up-to-date farm in Copper River valley, four miles from Gulkana. Oatfield in foreground



White Mountain, near Nabesna River, 100 miles northeast of Gulkana

Golden Rod Builds New Mill

The Golden Rod Mining & Smelting Co. is starting the erection of a concentrating plant on the Weiss land, south of Hockerville, Okla. The mill formerly used for handling the ore taken from this lease, the Hope, was destroyed by fire some months ago. Since then considerable drilling has been done, with results justifying the construction of a 300-ton mill.

Mill Tailings Not Taxable as Such in Utah

The United States Circuit Court of Appeals at St. Louis has affirmed the opinion of the trial court that Beaver County, Utah, could not tax the South Utah Mines & Smelters for a tailings dump. Values, according to the court, had already been taxed by the state, and the demand to return taxes paid thereon as personal property was affirmed.

Elkoro Develops New Orebody

It is reported that the Elkoro Mines Co., Jarbidge, Nev., which is operating the largest strictly gold mine in the State of Nevada, has developed new orebodies in hitherto unprospected areas on the Log Cabin property. The ore was first cut in a crosscut from the lower mill tunnel. It occurs in Tertiary rhyolites and has been mined to a depth of 1,400 ft.

Joplin Operators Secure Reduction in Compensation Insurance

After two public hearings, one at Jefferson City and one at Kansas City, the mine operators of the Joplin-Miami district succeeded in getting the proposed insurance rate for the new compensation law in Missouri reduced from an average rate of $11.40 to $8. Though this rate is still higher than is paid in most states that have workmen's compensation, it is considered the best that could be obtained, for the present at least. Certain provisions in the new Missouri law are responsible for the higher rate, and it is believed it may be possible to get these changed, and so bring about a lower rate. G. W. Johnson, district manager of the American Z. L. & S. Co.; A. T. St. Clair, of the Federal Mining & Smelting Co.; and Floyd Weed were the operators who attended the conferences, which were presided over by Ben C. Hyde, State Insurance Commissioner.

High-Grade Ore Found in East Tintic District, Utah

A large body of shipping ore has been struck in the North Lilly property of the International Smelting Co., Eureka,

Blue-Sky Law Proposed in Washington

Mining has several measures before the Washington State Legislature, including a securities act, and appropriations for topographic, hydrographic, and geologic surveys. For ten years the Northwest Mining Association has successfully fought the passage of any blue-sky legislation that would cover mining. Now that association and the Seattle Mining Club have agreed upon a bill which is somewhat similar to the Colorado Securities Act.

Reclamation Work Stopped at Barnes-Hecker Mine

All reclamation work has been discontinued at the Barnes-Hecker mine of the Cleveland-Cliffs Iron Co., Marquette range, Michigan, where 51 miners lost their lives on Nov. 3, 1926, and where 41 bodies remain entombed. The work of clearing the mine is considered far too hazardous, and contracting firms accustomed to such jobs refused to submit bids. There is a static water head of close to 600 ft. and no feasible plan for removing this obstacle. The mining company is to pay double compensation in all cases, and this will mean a bill of close to $500,000 over a period of six years.

In stopping this work William C. Mather, president of the company, stated:

"The directors have reluctantly come to the conclusion that they ought not to attempt the reclamation of this mine with the great risk of losing additional lives of employees in an undertaking the ultimate success of which is exceedingly doubtful. The officers of the company have naturally been extremely anxious to evolve a practicable plan by which the bodies could be recovered, and it is with the deepest regret that the directors have felt forced to come to this conclusion for the reasons mentioned, and they tender to the bereaved families their deep sympathy.

"Immediately after the accident instructions were given to accord especial financial assistance to the families of those who were lost, as circumstances dictated, and the directors have further decided that a donation will be made to each family, equivalent to that accorded to them by the Compensation Law, beginning Jan. 1, 1927, and extending for 300 weeks. This, of course, will also be applied to the family of William E. Hill, county mine inspector, who lost his life in this accident."

Mayflower-Old Colony Cut New Vein

Mayflower-Old Colony, near Calumet, Mich., has opened a copper-bearing vein in its crosscut from the 1,700 level of the shaft, at a distance 2,700 ft. west. The crosscut will be continued in the hanging wall to determine whether another amygdaloid bed lies in that area. A month's time probably will be devoted to pushing the crosscut forward.

The copper-bearing 5-ft. vein is unidentified and so far as known has not been opened in any other lands in the district. It lies just 30 ft. above a conglomerate bed which is an entire stranger to geologists, for no records even mention the existence of a conglomerate in this vicinity.

Michigan Governor Favors Research

Fred W. Green, Michigan's new Governor, is thoroughly in sympathy with the proposed iron and copper research project. He recommends an appropriation of $50,000 a year for this purpose. "The return to the state will be many times the appropriation," he says. Mr. Green comments that "over one-half of the business of the upper peninsula consists of copper and iron mining, and a large part of the population are dependent upon it. The known reserves of the merchantable grades of iron ore within a relatively short period of years will be exhausted."

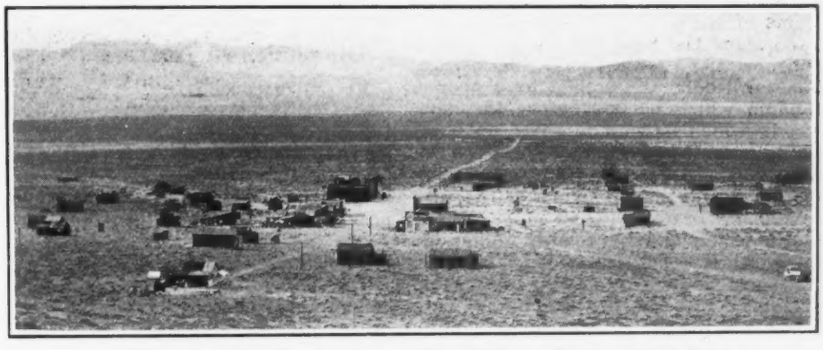
The Governor is fully in accord with the program of the Michigan College of Mines, at Houghton, to extend its engineering courses and change the name of the college to the College of Mining and Technology. He further states: "This will involve an increased appropriation, but we already have a large investment that will be safeguarded and made productive. There are many advantages in having a school of this character located in the upper peninsula, and this proposition has my unqualified approval. This institution stands high. It has a splendid superintendent and faculty and an unusually loyal alumni."

Gold Slope Mining Co. Plans Long Tunnel

The Gold Slope Mining Co., thirteen miles west of Willcox, Ariz., in the Dos Cabezas Mountains, is reported to have let a contract for the driving of a 2,200-ft. tunnel. It is expected that a copper vein will be cut at approximately 1,700 ft. in depth. Four veins are reported on the property.

Premier Gold Seeks Additional Property

The Premier Gold Mining Co. has bonded the Prosperity group of seven claims for $125,000 and has made an initial payment of $20,000. The company also has bonded three adjoining claims for $20,000 each, and already holds an option for $60,000 on the Melvin group, also adjoining. Prosperity group is situated on the north branch of the Marmot River in the Portland Canal mining division of British Columbia. Discovery of the group was made last summer. The five owners took out about 50 tons of ore from a 6-ft. vein, but were unable to get more than 30 tons packed down the mountain before snow closed the trail. The 30 tons was sent to the Trail smelter, and yielded returns of $6,499.46 after freight and treatment charges had been paid. The ore assayed 437.55 oz. of silver and 0.8 of gold per ton, 29.95 per cent lead, and 10.45 per cent zinc.



Hornsilver, Nev., where cyanide mill is under construction

Custom Mill for Hornsilver

A small cyanide mill is being constructed in Lidar Canyon, Hornsilver, Nev., to treat custom ores of the district. This venture is an experiment upon the part of C. M. Dawson, of Ely, and Andrew Ruf, of Goldfield. Water will be obtained from the Goldfield Water Co. It is expected that the mill will be in operation the latter part of January.

Consolidated Production $5,000,000 in Excess of 1925

The estimated metal output of the Consolidated Mining & Smelting Co. of Canada for 1926 is 50,000 oz. of gold, 6,846,000 oz. of silver, 21,760,000 lb. of copper, 248,800,000 lb. of lead, and 123,200,000 lb. of zinc. Value of the output is estimated at $37,223,235, compared with $32,667,731 in 1925.

Calumet & Arizona Investigates Oil Possibilities of Sonora

Dr. N. L. Taliaferro, petroleum geologist, of Berkeley, Calif., accompanied by his chief assistant, J. L. Dorrance, and Harry Lavender, chief engineer of the Calumet & Arizona Mining Co., have returned from Mexico, where they have spent some time in a thorough examination of the properties of B. L. Packard, pioneer Douglas banker and cattle man, known as the Turkey Track Ranch. The investigations were confined largely to the possibilities of finding oil formations on the ranch.

Nova Scotia Produced 650,000 Tons of Gypsum in 1926

Considerable attention is being directed to the gypsum deposits of Hants County, Nova Scotia. Exports of gypsum from this district during 1926 totaled 650,000 tons, valued at approximately $1,500,000. The largest operations are being carried on by the Canadian Gypsum Co., at Wentworth, about two miles from Windsor. The company operates two quarries, the Cables and the Meadow. The next important gypsum quarry is at Walton, where the Rock Plaster Co. has operated for a number of years. This company has been absorbed by the Atlantic Gypsum Products Co., of Boston, and it is understood that the operations there are to be extended greatly during the coming year. An agreement has been entered into between the company and the Avon River Power Co. for electrical power from Avon Falls by March 15.

News from Washington

By PAUL WOOTON
Special Correspondent

Oddie Stresses Need for More Funds for Bureau of Mines

A plea for additional appropriations for the Bureau of Mines was made in the Senate Jan. 20 by Senator Oddie, of Nevada, chairman of the Committee on Mines and Mining.

"As a practical mining man," Mr. Oddie told the Senate, "I have been convinced for some time that the output of this important Bureau was being very much hampered and reduced by reason of lack of funds for its efficient functioning. This is due to no fault of those in charge of the Bureau's work. They are splendid men, thoroughly equipped to perform their duties. I cannot speak in too high terms of them."

To show the need for the additional appropriations which he is suggesting, Senator Oddie prepared a long memorandum which he laid before the Senate, in which he said in part:

"A century of surface prospecting throughout the mineral areas of the United States has resulted in the discovery of practically all mineral deposits which can be readily found by this method.

"While known reserves are being rapidly depleted, the search for new deposits is becoming increasingly difficult, and a pressing need has arisen for the development of reliable methods of subsurface prospecting whereby mineral deposits which undoubtedly exist, concealed by rock, soil, or other covering, may be found.

"An appropriation of $25,000 a year is required, and a five-year program should be provided for to enable the Bureau of Mines to make an exhaustive study of geophysical methods as applied to the finding of ore and oil and to publish a report of these investigations which will make available to the mining industry reliable information regarding the practicability and usefulness of such methods."

In addition to stressing new prospecting methods, Senator Oddie called attention to the important work of the economics branch of the Bureau and its relation to the various branches of the mining industry; requested a study of the silver situation, and an investigation covering the world situation in gold. Safety work was also stressed.

Freight Rate on Zinc Ore Upheld

Existing freight rates on roasted zinc ore from Moundsville, W. Va., to Newport, Del., have been upheld by the Interstate Commerce Commission. The United Zinc Smelting Corporation, of Moundsville, contended that rates on zinc ore from Mississippi River crossings to eastern points were unduly prejudicial to the rate between Moundsville, and the commission in its decision points out that zinc ore shipped from the Joplin-Miami field is known both as zinc ore and zinc-ore concentrate. It was stated in the proceedings that zinc-ore concentrate does not describe roasted zinc ore adequately. Roasted zinc ore is a more valuable commodity than unroasted ore.

The Smelting Corporation also brought forward comparisons including the rate on iron ore, on iron pyrites and on roasted dolomite. The commission points out that these commodities are of much lower value than roasted zinc ore. As a consequence the complaint was dismissed.

Low Moor Iron Company Liquidates

After a history of upward of half a century in Alleghany County, Va., the Low Moor Iron Co. will soon cease to exist. At a meeting recently at Low Moor, the stockholders voted to carry out the resolution of their board of directors, that the affairs of the corporation be liquidated and that all properties be disposed of to the best advantage.

Oil Shales in North Carolina

Recent researches by the North Carolina Department of Conservation and Development reveal large reserves of oil shales in that state. The oil shales are found in the Deep River basin in what is known as the Triassic belt near the geographical center of the state, and principally in three counties —Moore, Lee, and Chatham.

The shales lie above the coal that is being mined at present, and from borings they are shown to have a thickness of from 35 to 40 ft. over a very large area. State Geologist Bryson points out that the average yield of petroleum per ton of shale is between 40 and 45 gal.

Longyear at Austinville, Va.

Certificate of authority has been issued to the E. J. Longyear Exploration Co., incorporated under the laws of the State of Delaware, by the Virginia State Corporation Commission to prospect, explore, drill, test, and develope mineral lands. The principal office of the corporation in the State of Virginia is to be at Austinville, Va., with George Eubanks in charge.

Southern Acid Plant Enlarged

The Southern Acid & Sulphur Co., St. Louis, Mo., has started construction of Units Nos. 7 and 8 of its sulphuric acid plant at Port Arthur, Tex. The contact process is to be used in these units as now planned.

Desert Queen Sinks Shaft

The Desert Queen Mining Co., which has a working lease and bond on the Donnelly gold strike at King, Nev., 16 miles from Broken Hills, the nearest post office, has installed a gasoline hoist and will sink the incline shaft to the 150 level. The shaft is now down 50 ft., and the vein has been crosscut and drifted on on this level.

The Desert Queen company is owned jointly by the Rosetta Divide, the Mexican, and the Argentum Mining companies, and is well financed for present work.

Tonopah District Shows Slight Improvement

General conditions in the mines of the Tonopah district, Nevada, are rather improved than otherwise, compared with those of a few months ago. The latest favorable development was made in the Tonopah Extension, on the 1,540 level from the McCane shaft in the extreme westerly workings. A west working from the Bermuda vein has cut a northwesterly striking northeasterly dipping vein which gives promise of becoming a very important producer. The west drift encountered a small fault, but the vein has been recovered, and now shows 12 ft. of $30 ore. The vein is reported to have a Mizpah trachyte footwall and a West End rhyolite hanging wall, both of which formations are ore bearing in the Tonopah district.

In the Rapp lease on a portion of the Rescue Eula property two west drifts on small veins are being run on the 800 level. The drifts both show narrow widths of high-grade ore, and a small tonnage is being saved for shipment. Rapp believes that he has found a faulted segment of the Valley View vein.

Nevada Mine Operators' Association Elect Officers

The fourteenth annual meeting of the Nevada Mine Operators' Association was held in Reno on Jan. 10, and the following officers were elected for 1927: John G. Kirchen, general manager of the Tonopah Extension Mining Co., president; A. H. Lawry, superintendent for the Goldfield Consolidated Mining Co., first vice-president; P. W. Racey, second vice-president; with Fred L. Cole, H. A. Johnson, W. S. Larsh, and H. D. Budelman as additional members of the executive committee. Henry M. Rives was re-elected secretary.

The silver market was discussed at length, and reports were presented which indicate the possibility of early favorable legislative action by Congress on the long-deferred completion of the provisions of the Pittman bill, under which 14,589,730 oz. of silver is still to be purchased.

Gold Mining at Low Ebb in Oregon

Gold mining in southwestern Oregon continues to attempt to emerge from the general state of depression into which it sunk during the war period. Much of the work done during the year just closed has been devoted to investigation and prospecting. The suspension was due primarily to the relative small amount of labor, equipment, and supplies that could be exchanged for the gold won. Most of the operation in this region in the last two years has been done by mining companies financed by men of comparatively small means, who make investments in mining from their surplus capital. Engineers scouting for large companies are especially desirous of securing gold and copper properties of merit, and their activities in this field presage a general resumption of mining.

During the general suspension of

mining in this region many of the miners left the state. There are still insufficient experienced men for the work now in progress. The wage scale is $5 for miners and $6 for shift bosses and tool dressers.

A very important single feature of mining in this region is the recent striking of the first free gold in telluride ore in the Kubli mine. This mine is three miles from Gold Hill and is an old-time producer of gold from oxidized ores. The vein is 5 ft. between walls and made up of 2 ft. of quartz, which contains the values.

The Beaver Portland Cement Co., which has operated steadily since 1917 and which employs 100 men, has begun to reconstruct the plant at Gold Hill, increasing production from 1,000 to 1,600 bbl. of cement per day.

The Hartman Syndicate, of Ashland, Ore., has acquired about 4,000 acres of oil-shale lands east of Ashland, and has spent $250,000 on the property, equipping it with a 250-ton capacity retort. The shale deposits are located on the foothills of the Cascade Mountains east of Ashland.

War Eagle Quicksilver Mine Sold

The sale of the War Eagle quicksilver mining property, Gold Hill, Oregon, to a Chicago syndicate, headed by W. Earl Phinney, has been consummated. The new concern is incorporated under the name of the Medford Reducing & Refining Co., with a capitalization of $2,000,000 and local headquarters at Medford, Oregon. A crew of 20 men has been employed for the last two weeks in preparing for actual opening of the mine and furnace. The property consists of about 800 acres of patented land and is equipped with a modern Scott furnace of 30 tons' capacity. H. M. Parks, formerly of the Oregon Bureau of Mines, is engineer in charge. The property produced 565 flasks of quicksilver during the war period.

Shattuck-Denn Continues Development

The Denn shaft of the Shattuck-Denn property, in the Bisbee district, in Arizona, has been deepened to approximately the 1,880 level, with the sinking reported favorable, in spite of heavy ground. The company expects to do some drifting at the 1,900 level before continuing with the sinking. Ore encountered on the 1,800, where extensive development work has already been done, indicates that ore of the same quantity and quality will be found when drifts are opened up 100 ft. below.

Placer Claims in National Park Null and Void

The Department of the Interior has decided that placer mining claims made by Senator Cameron, of Phoenix, Ariz.; the United States Platinum Co.; and others to locations in the Grand Canyon National Park in Arizona are null and void. The claims, twenty-eight in number, are said to contain valuable deposits of platinum, gold, and other minerals, and to overlie some of the scenic features of the national park.

Toronto Letter

By Our Special Correspondent for Northern Ontario

Hammell Finances Howey Property—Area and Amulet Disappointing

When the Dome dropped its option on the Howey property last spring, many people thought that Jack Hammell could never revive Red Lake. Hammell, however, is a man of wonderful enthusiasm and unconquerable optimism, and although many lost faith in Red Lake, Hammell never did. He has recently justified this optimism by putting over one of the most remarkable deals in the history of mining. A company was formed some time ago with a capital of 5,000,000 shares of $1 par, of which half was issued, and it was decided to issue a further 1,000,000 shares at 50c. a share. Before this issue could really be offered to the public it was oversubscribed. Such men as Harry Oakes, of the Lake Shore, and Al Wende, of the Wright-Hargreaves, took large blocks of stock and went on the board of directors, and mining men all over the north country showed their faith in Hammell by standing behind him and subscribing for the stock. A few days ago an advertisement of this issue appeared in the Toronto papers, headed by the unusual statement, considering that it applied to a mining issue,

> "As this issue has been sold, this advertisement appears as a matter of statistical record only,"

which is a real tribute to Jack Hammell's personality. H. G. Young, of the Castle-Trethewey, will be mine manager, and D. G. H. Wright, of the Dome, geologist of the property.

The first diamond-drill hole to be completed on the Area property, in Rouyn, in an effort to prove up the electrical indications, did not show anything of value, and this disappointment was reflected in the market, with the consequence that many speculators threw their stocks overboard, and Area sold down from a high of $1.95 to a low of 50c., from which point it has shown some recovery. It would appear that the directors had expected the first hole to at least encounter sulphides, the bet being whether the electrical indications pointed to barren sulphides or commercial ore. In a statement issued as soon as the directors themselves received word, it was announced that 30 ft. of core showed only a sparse mineralization, with traces of chalcopyrite. From that point on the drill penetrated barren lava. The small amount of sulphides was not sufficient to account for the electrical indications, so that there is considerable doubt as to the possibilities of further drilling. Under ordinary circumstances a single diamond-drill hole would not be given a great amount of weight, but the conditions in this case were so peculiar that some definite information was expected. In the meantime another hole has been started at a steeper angle, which will intercept the prospective zone at greater depth.

On the adjoining Amulet property, a drill hole was also put down on electrical indication, without encountering anything of value. At the present moment drilling on the Amulet is held up, as the diamond-drill bit has been lost in the hole.

There is a good deal of activity on other properties throughout the Rouyn district. Diamond drilling has been started on the Laval and Duprat properties, and the Mining Corporation, Nipissing, and Coniagas have given contracts for electrical surveys.

The Lake Shore mine, of Kirkland Lake, has started up its third ball mill, which, together with the new tube mill and classifier recently installed, has brought the tonnage up to 750 tons a day.

The Kirkland Lake Gold Mining Co. has decided to continue the shaft from 2,350 to 2,500 ft. At that horizon another hoist will be installed and sinking continued to a depth of 2,875 ft. On the 2,350 level the length of the new oreshoot has been opened up for a total distance of 185 ft., of which 60 ft. runs from $7 to $8 a ton and 125 ft. from $3 to $15 a ton.

Kafue Copper Dredging Disappointing

The Kafue Copper Development Co., Barkerville, B. C., has suspended dredging operations for the season, having cleaned up its leases on Antler Creek. The ground has yielded approximately $240,000, which result has been disappointing, as the ground was drilled by an expert, who estimated its content at close to $750,000. Despite the discrepency between the result of dredging and the estimate of the value of the ground, the dredging has been profitable. In the spring the dredge will be moved to Cunningham Pass Creek, three-quarters of a mile distant. It is expected that it will take several months for it to dig itself into profitable ground.

Livingston Mine Making Regular Shipments

The Livingston mine, in central Idaho, is shipping 150 to 300 tons of ore a day, using 26 trucks to haul over a road 63 miles long by one route and 73 by another, said A. J. Miller, flotation specialist, in an address before the mining bureau of the Spokane Chamber of Commerce. He also said:

"The appearance of the Livingston ore suggests a higher lead content than it possesses, because of the presence of antimony. The ore is largely jamesonite, but contains some galena. Because of the large content of jamesonite, it has not been possible to produce a high-grade lead concentrate—not more than 50 per cent. After the elimination of gangue, the millman is confronted with antimony. The ore occurs in large lenses 30 to 40 ft. wide."

Phelps Dodge Corporation Let Contract for 2,500-Ft. Shaft

The Phelps Dodge Corporation has awarded the contract to sink the company's new 2,500-ft. three-compartment Warren shaft at Warren, Ariz., to the E. J. Longyear Co. of Minneapolis, Minn.

Melbourne Letter

By Peter G. Tait

Special Correspondent

Golden Horseshoe Issues Statement—Oil Search Continued —Mount Lyell Company Expands

Melbourne, Dec. 15 — The management of the Golden Horseshoe Estates gold mine, Kalgoorlie, which recently closed down, has issued a statement reviewing the operations of the company since its inception. Up to June 30, 1926, 4,808,517 tons of ore was treated for 2,974,528 oz., valued at £12,786,519. Dividends paid totaled £3,652,500. Expenditure aggregated £8,487,829. Of this amount £4,024,083 was spent in wages and £3,606,727 in plant, stores, fuel, and other items. To the date mentioned 32.48 miles of development in the form of shaft sinking, drives, crosscuts, rises, and winzes, and about a mile of diamond drilling, were done. The average number of men employed underground and on the surface was 651.

Referring recently to the search for oil in Papua and the Mandated Territory of New Guinea, Sir William Glasgow, the Commonwealth minister for home and territories, stated that it had been decided to sink another bore on the Commonwealth reservation at Popo, Papua, and to arrange for further detailed geological surveys to be conducted in both territories.

The Taranaki Oil Fields, Ltd., which was floated in Australia several years ago with a flourish of trumpets to bore for oil in New Zealand, has sunk several bores, but so far without success. A second well is under way at Waiapu and another bore is to be put down in Taranaki district at Okoke, about 7 miles northeast of Tarata.

Copper mining in Australia has not been profitable since the low prices have been ruling, and as has been pointed out in this department the Mount Lyell is the only company of any importance producing in Australia. Even in this case continuity of operations has been possible only because of the foresight of the company in installing a hydroelectric plant and the fact that it has developed an important chemical and fertilizer industry. In addressing a recent meeting of shareholders, the chairman announced that the net profit for mining operations after providing for all expenses except taxation, but including no allowance for depletion of ore reserves, averaged about £26,000 per annum for the last five years, and this on a capital investment of approximately £800,000. The chairman went on to say that the directors did not anticipate a higher price for copper and that in the face of increasing costs they have been compelled to seek ways and means of insuring cheaper production.

As a result of the recent tour abroad of R. M. Murray, the general manager, it appears almost certain that the company will erect its own electrolytic refinery at Mount Lyell instead of sending the blister copper to the Electrolytic Refining & Smelting Co. in New South Wales. This will be a severe blow for the Electrolytic company, as Mount Lyell, since the restriction of operations at Mount Morgan, has been the principal source of supply. The cost of the plant to be erected by the Mount Lyell company is estimated at £75,000 and in view of the fact that the company has cheap hydro-electric power available, the building of the refinery seems a businesslike procedure.

The company is also giving serious thought to the possibilities of the manufacture of nitrates. It has large fertilizer works in Victoria and Western Australia, and there has recently been keen competition in this trade as the results of new farmers' co-operative works being established in several of the Australian states. To meet this competition the company has made a proposal to form a farmers' co-operative company in Western Australia and acquire a holding in its Western Australian works. The Mount Lyell company claims that no manufacturers can supply super-phosphates at a cheaper price than it can and still pay 10 per cent on capital invested. The company also has chemical works in Victoria, manufacturing caustic soda and chlorine products. It is now proposed to establish similar works in New South Wales.

Turning to the mining branch of the company's operations, it should be remarked that the company has completed the opening up of the Mount Lyell blocks shaft, which will facilitate the working of the orebodies in the northern part of the North Mount Lyell mine. The aim of the company appears to be to increase the output of copper and thus reduce the unit cost.

Mexico City Letter

By W. L. Vail

Special Correspondent

Mexican Mine Production Higher Despite New Laws— Zinc and Lead in Front Rank

The Mexican Department of Mines, under the direction of the Secretary of Industry, Commerce, and Labor, has completed a résumé for 1926, with respect to the mining industry. The larger companies, according to this report, have continued their operations, practically uninterruptedly, with a few exceptions, regardless of the depreciated price of silver, though other concerns have been enabled to carry on with low-grade ores, as a result of more intense work and more economic methods of extraction and operation. A comparison of metal productions for the years 1924, 1925, and 1926 shows an increase for the last-named year, of silver, lead, zinc, copper, mercury, antimony, manganese, and arsenic, with a slight falling off in the production of gold and coal. The reduction in the coal output is explained because of the failure, particularly of the National Railways, to continue the old contracts with the companies in Coahuila. These coal companies depend very largely on the railways and the mining companies, the latter being larger consumers of coke. The falling off in gold production is accounted for by the closing of the gold camps in El Oro, State of Mexico, and Tlapaujahua, Michoacan, which have been big producers.

Figures are given as follows for the three years covered by the report:

Mineral Production of Mexico

	Kilos		
	1924	1925	1926
Gold	24,647	24,541	23,445
Silver	2,884,104	2,889,119	2,900,000
Lead	165,062,786	178,661,677	206,500,000
Copper	50,061,513	54,596,160	56,200,000
Zinc	24,659,198	51,794,544	95,500,000
Mercury	36,655	38,721	40,950
Antimony	774,567	1,339,493	2,425,000
Arsenic	2,500,000	7,507,000	8,000,000
Graphite	8,023,417	6,263,894	4,550,000

The figures given in the table are set forth by the Mining Department as an argument that the new mining laws have not impeded the growth of one of Mexico's most important industries during the last year. Mining chambers throughout the country continue to disagree with the conclusions.

Another big reduction in workmen was put into effect last week at Dos Estrellas and adjoining properties in the El Oro and Tlapaujahua districts, in the states of Mexico and Michoacan, respectively.

Increases in the production of zinc and lead are due, according to the report, to the application of more modern methods, which have made possible the opening up of many old properties, abandoned years ago because complex ores and methods of treatment heretofore failed to achieve results.

Reorganization in most of the large copper camps of the republic, resulting in a considerable reduction of operating expenses, has more than compensated, it is stated, for the unsatisfactory prices which now obtain.

El Recuerdo Mine Shipping Ten Cars per Week

The North American Lead Corporation, operating the El Recuerdo and Anexas mines, at Vicente Guerrero, Durango, Mexico, reports that the steam-power plant and hoist are installed and operating. A sinking pump is being placed to handle the water while sinking the shaft another 100 ft. A 50-ton ore pocket is being placed below the third level to take care of the increased production from a new strike on the third level. This new strike has been crosscut from wall to wall a distance of 29 ft. and drifted on for a length of 70 ft., showing good grades of ore. A part of the vein is above the water level, and the ore is lead carbonate, of which about 60 per cent is shipping grade averaging 15 per cent lead and 12 oz. of silver. The remainder is good milling ore. At and below the third level the ore begins to show as a fair amount of galena.

Since the installation of the hoist, shipments have been at the rate of ten 36-ton cars weekly. While sinking the shaft one shift will be devoted to hoisting ore and the other two shifts will be utilized in sinking the shaft and drifting. During the year that the company has been operating the mines, shipments amounted to 125 36-ton cars, yielding a good operating profit.

London Letter

By W. A. Doman

Special Correspondent

Panama Corporation in Prospecting Stage on Isthmus —Gold Concession in Venezuela

London, Jan. 11—In the *New York Herald-Tribune* of Dec. 26 is an article about the activities of the Panama Corporation. A perusal of this article suggests that the Corporation is doing a large amount of work. Substantially, this would appear to be correct, though so far as I can gather the position is a little exaggerated. Reading the article critically, I should say that someone on the spot had a friend in the newspaper world, and sent him a description of the work in progress, writing in such a manner as to hint that very active operations are in progress. The company has an option on the Romance mines, and is testing this property, but so far there is nothing that would justify its being termed "a payable proposition." In the Darien part of the concession an alluvial gold deposit is being tested, and this gives encouragement to proceed. The source of the Veraguas deposit has not yet been traced, but should it be discovered higher up the Veraguas River the whole of the mineral-bearing area will be within the Corporation's concession. The most I can gather is that there are hopes of something important being found. Should the Romance mines or anything else turn out to be profitable, separate companies will be formed to work them. Hitherto transport has proved an obstacle. This, however, is being provided, and it would appear that the Corporation is spending something like £36,000 a year in its operations, a fair amount, though not large in relation to the £500,000 cash capital raised. Altogether, the flourish of trumpets with which the Corporation was heralded has yet to be justified. The only technical man on the board is Walter Broadbridge.

Another company formed to work mineral deposits in this part of America is the New Goldfields of Venezuela, Ltd. The gold-mining concessions are situated in the State of Bolivar, adjacent to El Callao, and covering an area of more than 30 square miles. The statement of particulars mentions that during the latter part of last century more than £5,000,000 worth of gold was produced. Noel G. Hackney has reported upon the district, and he states that "the indicated ore content above the 500-ft. level substantially exceeds 20,000,000 tons, with a value, assuming an extraction of 9 dwt. per ton, approaching £40,000,000."

One of the Nigerian tin-mining companies, the Kaduna Syndicate, is dispatching a prospecting party to Uganda to examine a reported tin-bearing concession. Two mining engineers are said to be leaving London during the current month.

Revival of Copper Mining in Wales

There is a suggestion that copper mining in Wales is to be revived. The Nantmor Copper Co., Ltd., has been formed to work a property in the Snowdon district. Little has been done in the way of copper mining in Wales since 1860, but two or three engineers who have examined the Nantmor are enthusiastic as to the outlook. There are indications of various copper lodes, and the property, consisting of a hill about 900 ft. in height, is thought to be more or less copper-bearing throughout. A ropeway is being constructed, and the concentration mill should be completed about the end of the current month. The miners are to be given an opportunity of taking an interest in the property, and a number of "labor shares" have been created.

Within the last few days it has been stated that funds are being put up to resume operations at lead-zinc mines in Carnarvonshire, England. E. T. McCarthy has examined the property and it is apparently on his report that the capital is being provided.

Near Puka, in Albania, copper mines have been discovered which it is said promise a yield of 30 per cent. The Copper Mine Puka Albania Co., Ltd., Belgrade and Skutari, formed under the protection of the Serbo-Albanian Bank, with a capital of 5,000,000 gold francs, is entrusted with the exploitation.

Mimbula Copper Deposit

At the annual meeting of shareholders of the Rhodesian Congo Border Concession, Ltd., Francis L. Gibbs, the chairman, had some interesting information to impart. The prospects of the N'Changa mines are well known, but there is another copper deposit—the Mimbula—about 10 miles to the south, with an area of 5 square miles, that seems to have equally good prospects. A large part of this area has been investigated. Numerous shallow shafts put down in various places have definitely proved the existence of a very large tonnage of low-grade oxidized ore, of a probable value of 1.5 per cent to 2 per cent copper.

Hudson's Bay Co. Vs. Canadian Government

A case of far-reaching importance between the Hudson's Bay Co. and the Canadian Government as to the ownership of minerals is now pending before the Supreme Court of Canada. The question brings up old history. By letters patent granted by King Charles II, May 2, 1670, the "Gentlemen Adventurers of England" were granted privileges and territory in that portion of the Northwest known as Ruperts Land. By deed of surrender Nov. 19, 1869, the Gentlemen Adventurers company surrendered to Queen Victoria all the rights, privileges, land, and authority granted to the company in its charter. This surrender was duly accepted on June 23, 1870, when Ruperts Land and the Northwest Territory were admitted into the Dominion of Canada. In return for this surrender the Hudson's Bay Co. was permitted to select certain land within the fertile belt of the Northwest Territory. Conveyances of these lands were made from time to time, but neither in the conveyances nor in the patents was any express mention made of minerals.

Johannesburg Letter

By John Watson

Special Correspondent

November Gold Production Shows Decline—Origin of Platinum and Gold Discussed

Johannesburg, Dec. 14—The output of the Transvaal gold mines for November was declared by the Chamber of Mines on Dec. 10 as 840,276 oz., having a value of £3,569,266. These figures show a decrease of 13,020 oz., equal in value to £55,305, compared with October.

At the monthly meeting of the Geological Society of South Africa, held in Johannesburg on Dec. 6, Dr. P. A. Wagner, discussing the origin of the platinum deposits in the Bushveld, replied in detail to the views of Prof. A. Lipovsky. Dr. Wagner has insisted all along that sulphur has acted as a collector of the platinum, probably assisted also by arsenic. Dr. Wagner also read a supplementary note on a new gold discovery in the Rustenburg district, reporting the occurrence of a gold telluride, in the ore, identified as Krennerite ($AuTe_2$). This was first noted in a specimen recently brought from Waaikraal by S. de Smidt, Deputy Inspector of Mines, Pretoria.

Gold is present in the Waaikraal ore (a) in the native or free state, (b) intergrown with gold telluride, and (c) as gold telluride occurring independently of free gold. Waaikraal furnishes the first illustration of gold telluride occurring as a primary constituent of an igneous rock, as a direct separation from a silicate magma.

The London and Rhodesian Mining Co. has taken on option a number of blocks of ground in the Que Que district, in Southern Rhodesia, where a recent gold strike was made, and the company will investigate values.

Transvaal alluvial diamond diggings during October had a monthly output of 126,811 carats valued at £531,719.

Crisis in the Japanese Superphosphate Industry

The Japanese superphosphate factories, according to a report from Tokio, closed their plants from Dec. 15 up to Jan. 15. During the following months a reduction of production by 20 per cent will take place. These measures are to be traced to the fact that sales have largely decreased and stocks have accumulated. All works are obliged to submit to the producers' association every month exact data about sales, production, and other details.

Aluminum Company Investigating Soviet Ore Deposits

The expedition sent by the Aluminum Company of America to investigate aluminum deposits in the Soviet Union is now conducting research in the Batum region and the northern Black Sea Coast. Rich deposits of aluminum ore were discovered in the Gandja district of Azerbaijan.

Societies, Addresses, and Reports

Features of A.I.M.E. Program February Meeting

THE complete program of the 135th meeting of the American Institute of Mining and Metallurgical Engineers, to be held at New York Feb. 14 to 27, has just been issued. The sessions will be held at 29 West 39th St. Sessions and papers of most interest to the metal-mining and petroleum industries are shown below:

MONDAY, Feb. 14

Mining and Milling

10 a.m.—Room 502

Galen H. Clevenger, Chairman

"Degree of Liberation of Minerals in Alabama Red Iron Ores After Grinding." W. H. Coghill.

"Beneficiation of Alabama Siliceous Red Hematite." Joseph T. Singewald, Jr.

"Recent Developments in Classification." A. M. Goudin and W. L. Remick.

"Deep-Hole Prospecting in Eagle-Picher Mines." W. F. Netzeband.

"What Are the Limits to Mining Timber Preservation?" George M. Hunt. (Presented by the Committee on Mine Timber Preservation.)

"Potential Source of Asphalt-base Hydrocarbons in Northern Alberta." S. C. Ells. (Introduced by Alfred W. G. Wilson.)

"Mine Finance." Samuel H. Dolbear.

Mining Methods

12.15 p.m.—Mining methods luncheon at the Engineers' Club, Room 4. A round-table session will be held at 2 p.m., to discuss the report on the special investigation of mining schools made for the Society for Promotion of Engineering Education.

2 p.m.—Room 502

George A. Packard, Chairman

"Acceleration Stress in Hoisting Cables in Theory and by Test." G. P. Boomsliter. (Introduced by I. C. White.)

"Liquid Oxygen Explosives in Strip Coal Mining." G. B. Holderer.

"Hardness and Toughness of Rock." Emile E. Gyss and Henry E. Davis.

"Standard Maps for Iron Mines." Report of a special committee. Donald B. Gillies.

6 p.m.—Industrial Relations dinner.

6 p.m.—Milling Methods dinner at the Engineers' Club.

Institute Smoker

8.15 p.m.—Mecca Temple Mosque, 133 West 55th Street. Tables will be arranged so as to group members interested in the same phases of mining and metallurgy, thus permitting those who have interests in common to be together. The tables will be placed so that members and guests may conveniently visit from table to table.

TUESDAY, Feb. 15

Annual Business Meeting

10 a.m.—Auditorium. Third floor President S. A. Taylor in the chair. Presentation of the reports of the president, secretary and treasurer and other officers respecting the business of the Institute during the year 1926.

Election of officers for the year 1927.

Following the formal business of this session the meeting will be thrown open for the discussion of any Institute matters that may be brought forward by members.

Joint Session

2 p.m.—A joint session of A.I.M.E. with Mining and Metallurgical Society of America is scheduled for Tuesday afternoon. The subject will be "The Exhaustion of Mineral Resources." Clinton H. Crane, president of the Mining and Metallurgical Society, is to preside.

WEDNESDAY, Feb. 16

Mine Ventilation

9:30 a.m.—Room 903

A. C. Callen, Chairman

Report of Committee on Physics of Ventilation—A. C. Callen.

Report of Committee on Metal Mine Ventilation—D. Harrington.

"Underground Air Conditions and Ventilation Methods at Tonopah, Nevada." B. O. Pickard. (Discussion led by D. Harrington.)

"Ventilation of the Liberty Tunnels." Louis F. Huber. (Discussion by Ole Singstad.)

"Use and Danger of Booster and Auxiliary Fans as Applied to Coal Mining Ventilation." H. I. Smith.

Petroleum Engineering

9:30 a.m.—Room 501

T. E. Swigart, vice-chairman, presiding.

"Some Problems in Foreign Petroleum Operations." Chester A. Naramore.

"Some New Aspects of the Gas Lift." E. O. Bennett and E. C. Sclater.

"Advances During 1926 on Water Drive and Other Methods in Bradford Field." J. B. Umpleby.

"Core Studies of the Second Sand of the Venanga Group." Charles R. Fettke.

"Capillary Retention of Petroleum in Unconsolidated Sands." L. C. Uren and A. H. El Difrawi.

"Recovery of Gasoline From Natural Gas in Mexico." O. A. Larrazola.

"Advances in Casinghead Practice—Absorption Method and Recompressors." George P. Bunn.

"California Practice in the Transmission of Highly Viscous Oils Through Pipe Lines." A. S. Jones.

"Review of Drilling Equipment Advances." Ward B. Blodget.

"Bituminous Sands of Northern Canada." S. C. Ells.

Note—The meetings of the Petroleum Division will run in two parallel sessions through Thursday. The annual dinner of the division will be held Thursday evening.

2 p.m.—Room 501. Petroleum session continued

Mining Geology

2 p.m.—Room 903

E. F. Burchard, Chairman

"Geology of Pioche, Nevada, and Vicinity." L. G. Westgate and Adolph Knopf.

"Drainage in the Red Iron Ore Mines of the Birmingham District, Alabama." W. R. Crane.

"Magnesite Mining in California." Leroy A. Palmer.

"Clays of Southern California." Robert Linton.

"Relation of Disseminated Copper Ores in Porphyry to Igneous Intrusives." W. H. Emmons.

"Manganese Ore Deposits of the Gold Coast, Africa." A. E. Kitson, with "Notes on the Petrology of Certain Associated Manganese - silicate-bearing Rocks," by N. R. Junner. (Presented by E. F. Burchard.)

"Collection of Elements at American Museum of Natural History." George F. Kunz.

7 p.m.—Reception at the Waldorf-Astoria.

7:45 p.m.—Banquet.

Presentation of James Douglas Medal.

Presentation of the W. L. Saunders medal.

Presentation of the J. E. Johnson, Jr. award.

THURSDAY, Feb. 17

9:30 a.m.—Room A. Petroleum session.

2 p.m.—Room 501. Petroleum session.

Non-Ferrous Metallurgy

2 p.m.—Room 502

Arthur L. Walker, chairman

"Acceleration of the Rate of Oxidation of Ferrous Iron in the Presence of Copper and Its Application to the 'Heap Leaching' Process." E. Posnjak.

"Copper Alloy Systems With Variable Alpha Range, and Their Use in the Hardening of Copper." M. J. Corson, and "Notes on the Atomic Behavior of Hardenable Copper Alloys." E. C. Bain.

"The Tarnish Resistance and Some Physical Properties of Silver Alloys." Louis Jordan, L. H. Grenell and H. K. Herschman.

"The Application of Microtome Methods to the Preparation of Soft Metals for Microscopic Examination." F. F. Lucas.

Petroleum Division

6:15 p.m.—The Petroleum division of the A.I.M.E. will hold a subscription dinner at the Engineers' Club, immediately preceding the general session which will be held at 8 p.m. in the Engineering Societies Building adjoining the Engineers' Club.

8 p.m.—Petroleum General Session
Reviews for 1926
F. Julius Fohs, Chairman
"Production and Development in 1926." James H. Gardner.
"Advances in Refining Technology." Charles H. Osmond.
"Advances in Production Engineering." T. E. Swigart.
"The Trend of the Petroleum Situation." Joseph E. Pogue.

Excursions

The Excursions Committee has planned to give the visiting members opportunity to see something that they are not likely to see "out West" and, at the same time, to provide enough variety in the trips so that most of the visitors will be interested in some of the sights offered. No general excursion has been arranged, because the weather in February is too unreliable. Instead, eight separate excursions have been planned, each limited to a number of members.

Woman's Auxiliary

For Monday the Woman's Auxiliary has provided shopping tours, visits to art galleries, the Spanish Museum, tea at the home of Mrs. George F. Kunz, and a theater party in the evening. On Tuesday the annual meeting and election of officers, will be held and there will be an entertainment and tea, and a special entertainment and dance in the evening. On Wednesday there will be visits to the Stock Exchange and the Chamber of Commerce; lunch at Fraunces' Tavern; a visit to the National Arts Club, and in the evening the banquet at the Waldorf-Astoria.

Missouri School of Mines Chapter, A.I.M.E, Holds Meeting

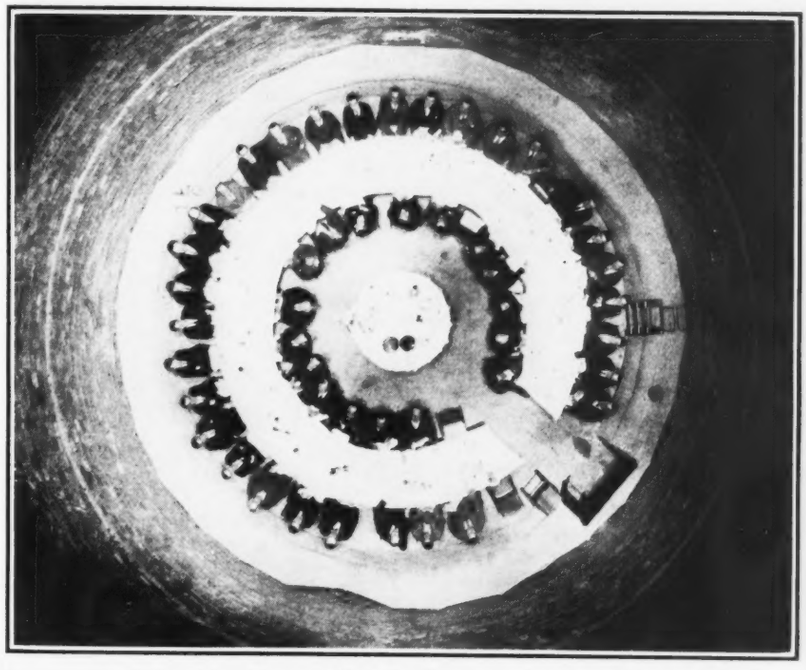
On Dec. 14, 1926, the Missouri School of Mines chapter of the A.I.M.E. held its second meeting of the school year. The principal address was by F. A. Corbett, superintendent of the Iron Mountain Mining Co., Iron Mountain, Mo. His subject was "The Relation of Geology to Dollars and Cents," and proved to be intensely interesting as well as of informational value. Mr. Corbett is a man of most varied experience in mining and was graduated from the South African School of Mines and Technology at Johannesburg.

Mining and Metallurgical Society Plans Metal Surveys

World surveys of the economic position of copper, lead, zinc, and silver are to be made by the Mining and Metallurgical Society of America, if the program outlined at the regular annual meeting of the society, held at the Harvard Club on Jan. 13, matures. The chairmen of the committees outlined their plans and asked for the co-operation of the society as a whole. The chairmen are: copper, Fred Hellmann; lead, J. R. Finlay; zinc, W. R. Ingalls; silver, George H. Garrey. Officers for the ensuing year are to be: Clinton H. Crane, president; S. H. Ball, vice-president; Percy E. Barbour, secretary-treasurer.

Phelps Dodge Reverberatory Plant at Douglas Nearing Completion

At a banquet in the bottom of the 350-ft. stack at the new smelting plant of the Phelps Dodge Corporation at Douglas, Ariz., fifty-five of the men who have been intimately connected with the construction of the new plant recently celebrated the completion of the work which was begun in February, 1925. G. H. Dowell, manager of the Copper Queen Branch, told of the construction of the first reduction works in Douglas in 1904, when the smelter was moved from Bisbee to Douglas. The original Douglas plant was a blast-furnace smelter, and in 1912 two reverberatory furnaces were added. The need for the application of up-to-date smelting practices had been realized for a long while, and after much discussion by department heads and many months of calculation the board of directors had been asked for an appropriation for the remodeling of the works.



An unusual banquet scene, in the base of the new Phelps Dodge smelter stack at Douglas, Ariz. The stack is 25 ft. in diameter at the base and 351 ft. high. Smoke poured from the top, being admitted above the diners, while the banquet was going on

Mr. Dowell then introduced D. D. Irwin, general superintendent, whose address was largely in praise of the Dwight P. Robinson Construction Co., which had carried out the work in less time and at less cost than for any similar job of which he had record, according to Mr. Irwin. George D. Neville, superintendent for the construction company, responded, and then J. M. Samuel told of some of the unusual constructional details of the work.

Colonel Stout, consulting metallurgist for the corporation, designed larger roasters, with additional heating surfaces. At a conference of Phelps Dodge officials, it was decided to change the plans and provide for super-imposition of the roasters on the reverberatories. This was a new idea in smelting practice, but was carefully planned, and the new plant is expected to function successfully. The principal savings effected by the new system will be through the transfer of calcines by gravity rather than mechanical means, the elimination of temperature losses caused by mechanical transfer, and the saving in dust loss because all calcine transfers are in closed circuits. Smelter work will be more pleasant and healthful because of the compact nature of the plant and the elimination of dust.

The new reverberatory plant consists of two reverberatory furnaces, twelve eleven-hearth roasters, and a Cottrell system. Having a capacity which will equal that of the present plant, the new one occupies but a fraction of the space occupied by the old plant. Four 500-hp. boilers utilize the waste heat and develop electrical energy for Copper Queen operations in Bisbee. The new plant is the last word in metallurgical practice and utilizes all proven labor-saving devices and safety appliances. When in complete operation it will eliminate the entire battery of blast furnaces and the two reverberatories now in use. A few of the old blast furnaces and the old roaster buildings will be used in the new lead smelter, construction of which will begin immediately.

San Francisco Section A.I.M.E. Holds Meeting

On Tuesday, Jan. 11, at 7:30 p.m., the regular monthly meeting of the San Francisco section of the A.I.M.E. was held at the Engineers' Club, San Francisco. T. A. Rickard, having recently returned from an extended and protracted trip abroad, addressed the meeting, his subject being "Recent Impressions of Europe."

People You Should Know About

W. A. Carlyle has returned from Italy, and is again residing at Victoria, B. C.

Louis A. Wright has returned to San Francisco from a professional visit to Spain and Italy.

Arthur Burns, mining engineer of New York, sailed for London on Jan. 22 for a month's stay.

George W. Malone, of Reno, has been appointed State Engineer for Nevada by Governor Fred Balzar.

Henry de Witt Smith has been appointed assistant managing director of the United Verde Copper Co.

A. M. Campbell, mining geologist, has resigned from the board of the Gold Exploration Co. of Canada, Ltd.

Paul Billingsley, chief geologist of the International Smelting Co., has returned to Salt Lake after a visit to Montana.

Charles Clark, Jr., of the United Verde Copper Co., has been visiting properties of the Democrata Copper Co., at Cananea, Mexico.

C. W. Nichols, president of the Nichols Copper Co., sailed for South America on Jan. 15. He will return to New York in March of this year.

Charles A. Mitke has returned to Arizona from an extended trip to Lower California, where he examined a number of copper and iron properties.

Commodore Clinton H. Crane, president of the St. Joseph Lead Co., has been re-elected president of the Mining and Metallurgical Society of America.

Lieutenant Colonel R. F. J. Weeks, of Florida, on the West Rand, left Johannesburg on Dec. 11 to take up an important mining appointment in the Guelo district.

William A. Willis, manager of the Copper and Brass Research Association, has gone abroad to make a survey of European conditions as they affect the copper market.

Dr. Leo Krige, government geologist, left Pretoria about mid-December for Capetown, with his sister, the wife of General Smuts, on a month's holiday visit to their mother at Stellenbosch.

E. A. Julian, manager for the Wingfield mining interests, was in Reno from his San Francisco headquarters to attend the meeting of the Nevada Mine Operators' Association on Jan. 10.

Roy Starbird and **Clarence R. King** sailed from Los Angeles on Jan. 3 for Chile and Bolivia on examination work for Yeatman and Berry, of New York. **Edwin S. Berry** joined them at Panama.

Lynn Thompson, manager of the Cardiff Mining & Milling Co., operating in Big Cottonwood Canyon, near Salt Lake City, Utah, spent the first two weeks of January at Los Angeles.

Frank Morehouse, of New York, who with associates is treating tailing dumps left by the Spaniards near Pachuca, Mexico, recently spent several days on business in Salt Lake City.

E. P. Mathewson, professor in the University of Arizona, addressed the Southern California Section of the A.I.M.E. on Jan. 25, at Los Angeles. His subject was "The Methuselah of Mines."

Professor Arthur E. Drucker, mining and metallurgical engineer, was recently appointed dean of the School of Mines and Geology of the State College of Washington, at Pullman, Wash. Dean Drucker has had a highly varied experience in examination and consulting work, has developed two original processes for the recovery of gold and silver, which have been widely adopted, and has many inventions to his credit.

Arthur E. Drucker

He has also contributed a large number of technical papers to publications serving the mining and metallurgical industries. Work at the Washington State mining school has been organized into two departments, that of geology and mineralogy and the department of mining and metallurgy. Under Dean Drucker's direction, an intensive campaign of observation and research, covering mines and plants in the important mining fields adjacent to the State of Washington, will be conducted.

Philip Clark, formerly an operator of Eureka, Utah, and **George H. Short,** of Salt Lake City, consulting engineer, are developing the old Greek American mine, in the Shell Creek range in eastern Nevada.

Robert E. Tally, general manager of the United Verde Copper Co., has been appointed a member of the Arizona Commission to represent the state at Washington in its fight against the Swing-Johnson bill, relative to development of the Colorado River.

G. R. Stevens, Canadian Government Trade Commissioner, arrived in Salisbury, South Africa, on Dec. 6, after a three months' survey of Central and East Africa. Speaking of Katanga, he said there is no such concentration of mineral wealth elsewhere in the world.

John R. Villiers, who had been associated with the firm of Mocatta & Goldsmid, silver brokers, of London, for thirty-five years, retired on Dec. 31, 1926. His son, **Arthur H. Villiers,** who has been with Mocatta & Goldsmid for some years, has been taken into partnership.

S. A. Moulden, of Adelaide, South Australia, has, on account of ill health, resigned as chairman of directors of the Broken Hill South, Ltd., a position which he had held since 1910. He first joined the board, as a director, in 1896. **Sir Frank Moulden** has been appointed to fill the vacancy.

William Russell, managing director of The Dorr Company, Ltd., London, England, arrived in New York on Jan. 10 and will make his headquarters with The Dorr Company, 247 Park Ave., New York City. While in this country Mr. Russell will familiarize himself with engineering achievements in the United States since his last visit eighteen months ago.

Engineering and Mining Journal has received twenty-five copies of the Annual Number of *The Mining and Industrial Magazine of Southern Africa* as a courtesy from the publishing company. We shall be glad, on receipt of 20c. to cover postage, to send these to anyone wishing them.

Obituary

Yovan Tsivitch, geographer and geologist, died in Belgrade on Jan. 10.

Thomas J. Ryder, formerly associated with the Guggenheim interests and long identified with oil development in Mexico, died in New York City on Jan. 20.

Alfred Langford, a pioneer of the South African diamond fields, died at Beaconsfield, near Kimberley, on Dec. last, aged eighty-two. He arrived in Kimberley in 1870.

Richard La More, veteran employee of the Shattuck-Denn Mining Corporation, was killed instantly on Jan. 17, when an air compressor in the mine building exploded. He was sixty-seven years old.

Charles Frederick Brooker, chairman of the board of directors of the American Brass Co., died on Dec. 20, 1926, in his eightieth year. Mr. Brooker had served the above-named company for sixty-two years.

Captain William Bond, a well-known mining figure of the Lake Superior district, died suddenly in Ironwood, Mich., on Jan. 7. He was born in Cornwall, England, sixty-seven years ago, and mined on the iron-ore ranges for almost forty years.

Robert Pincard, of Sault Ste. Marie, Ont., died on Jan. 19 at the age of thirty-five. He was born at Three Rivers, Quebec, and came to the Sault nine years ago. Mr. Pincard was engaged extensively in prospecting in the Algoma gold fields, where he acquired large interests.

Emil Melzer, mining engineer and metallurgist, died suddenly at Baker, Ore., on Dec. 17, 1926. He was one of the pioneers of mining in the Blue Mountains mining district of Oregon, having gone there in 1896. He was manager of the North Pole Mine from 1896 to 1908. Mr. Melzer was born in Saxony in 1862, and graduated from the Mining Academy at Freiberg in 1887. In late years he had been engaged as consulting engineer and in private enterprises at Baker.

New Machinery and Inventions

Waste-Heat Boiler Adaptable to High Operating Pressures

A steam generator for operation with the waste heat from industrial processes has recently been introduced by the La Mont Corporation, 200 Fifth Ave., New York, N. Y. The features of this generator are said to be the employment of small tubes, big reduction in weight and space required per unit of capacity, rapid steaming, and a high factor of safety.

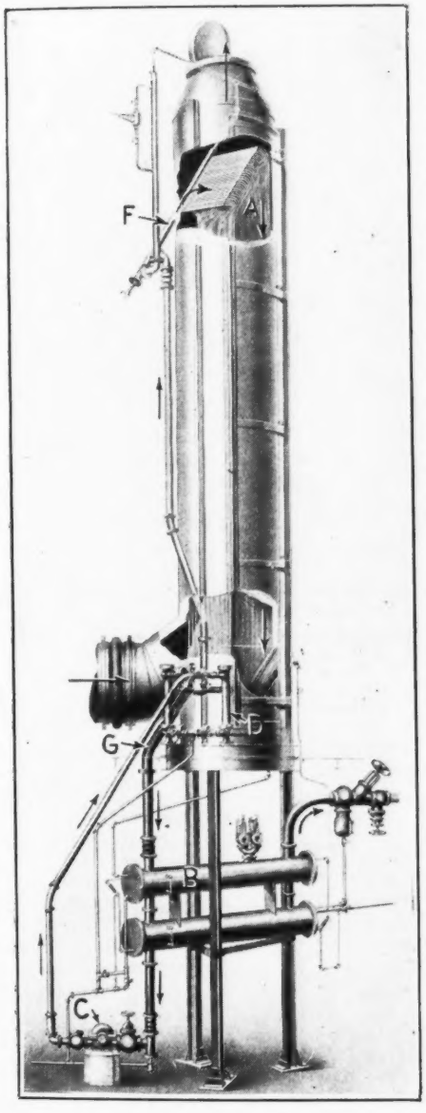


Fig. 1—Phantom view of steam generator. This view shows the arrangement of the tube banks, the close spacing being evident

In operation, a small quantity of water is injected into the top of a long ⅝-in. tube so as to form a film on the walls of the tube. As it passes down the tube, part of it is evaporated. This steam and the remaining water pass from the lower end of the tube into a header and thence to a separator, where the steam is removed and passes into the steam header.

Referring to Figs. 1 and 2, the boiler consists of a number of banks of tubes, *A*, inside a vertical shell, a separator, *B*, a circulating pump, *C*, and a duplex strainer, *D*.

The tubes in each bank are expanded top and bottom into headers, *E*, which in turn connect to the header, *F*, at the top and *G* at the bottom. Tubes are spaced about ½ in. apart at the top and ⅝ in. apart at the bottom and are staggered relatively to each other. This close spacing of small tubes is possible because of the film evaporation principle. The resulting straight upflow of the heating gases gives a high velocity and effective heat transfer with minimum draft loss.

In Fig. 3 is shown the method of injecting water into the tubes. The small jet tube, *H*, is inserted in the header, *E*, and the water enters each tube at the center through a small orifice. As the water strikes the sides of the tube it forms a film on the tube wall. As a result, violent ebullition takes place. The forced circulation, aided by gravity, continually washes the steam bubbles from the tube surface, resulting in high heat transfer and insuring a continuously wet surface.

The generator is not, however, a flash boiler, as the water is introduced at the coolest end of the tube, absorbing an increasing amount of heat as it flows downward. Also, from four to five times more water is injected into the tube than can be evaporated with the available area.

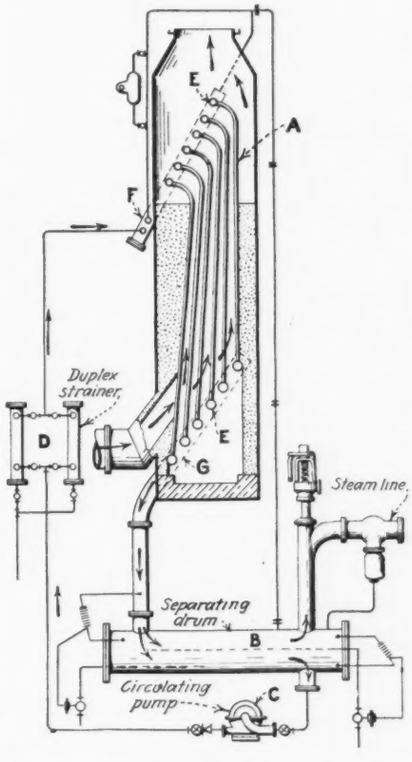


Fig. 2—Diagrammatic view of steam generator. The arrangements of the parts and piping, as referred to in the text, is shown in this sketch

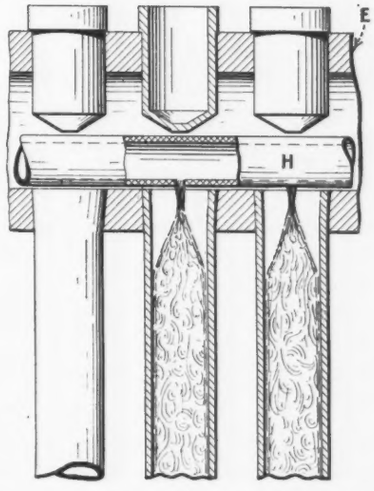


Fig. 3—Section of top header of steam generator with jet tube in place

Referring to Fig. 2, the steam and water are discharged into the separator, *B*, where the steam is liberated. The unevaporated water, which is maintained at a relatively high temperature by the constant circulation, mixes with the feed water, and a large portion of the carbonates and sulphates are precipitated in this drum and removed by blowing down. To prevent any impurities, other than those held in solution in the water, passing to the upper inlet header, *E*, and blocking the jets, a duplex strainer, *D*, is inserted in the circulating system. This is blown down at intervals. It is claimed that, owing to the high temperatures of the water entering the tubes and the washing action of the descending film together with the precipitating action in the separator and strainer, the boiler tubes are practically non-scaling.

The heating surface is incased in a ¼-in. round sheet steel casing with a door opening large enough to make the entire heating surface visible and removable. The shell is self-supporting from a ring base at the bottom, and this ring can be supported from three points at any height desired by suitable supports.

Although this boiler was designed primarily for use as a waste-heat boiler and the initial installations have been along these lines, it is readily adaptable for primary service.

Among the advantages claimed for this boiler is its adaptability to the high operating pressures now being introduced. Owing to the small size of the tubes and separator used, comparatively little change is necessary to make the boiler suitable for any pressure now being used, even up to 1,200 lb. per square inch. In its present form it can be used to provide greater power at high pressure in connection with existing lower-pressure boilers by connecting the gas inlet to one of the passes of the existing boiler.

Market and Financial News

January Mining Dividends Show Big Increase

Larger Distributions by Kennecott and Consolidated Smelting Swell the Total Over Previous Corresponding Quarters

By E. H. Robie
Assistant Editor

MINING DIVIDENDS paid in January are almost $5,000,000 greater than those paid for the previous corresponding quarter, in October; are about $1,000,000 greater than six months ago; and are about $4,400,000 more than was paid in January, 1926; thus reflecting the increased prosperity of some mining companies in spite of a gradual decline in metal prices that has now persisted for about five months. Doubtless production costs have declined as well as the prices realized for mine products. In the list at the bottom of this page are shown the dividends paid in January by mining and metallurgical companies operating in North and South America, together with the dividend yields on the stocks of those companies that are on a regular dividend basis, based on the January distribution except as noted, and on recent market prices.

Kennecott's increase in its quarterly dividend, from $1 to $1.25, was not unexpected in view of its excellent earnings. As is well known, this company owns, in addition to its Alaskan property, about 95 per cent of the stock of Utah Copper and more than 99 per cent of Braden; it also controls Mother Lode Coalition. During 1923, 1924 and 1925 it paid but 75c. a quarter; last year the rate was $1; and now it is $1.25. This, however, is not quite equal to that paid at the peak of war prosperity in 1916 and 1917, when $1.50 was paid for a time.

The bonus paid by the Consolidated Mining & Smelting Co. of Canada amounted to $5 per share, the same as was paid last January, but the regular dividend has been doubled, from 75c. to $1.50, payment being made semi-annually. The bonus paid last July was $3. The Consolidated's manner of paying dividends is different from that of most companies, the regular dividend being small compared with the bonuses. Financial data are not willingly released to American inquirers by this company. It has been reported recently that the Canadian Pacific Railway owns $5,785,325 of the $12,675,300 stock outstanding of the Consolidated company.

Homestake seems to have acquired the habit of paying a dollar extra every January, in addition to its regular monthly distribution of 50c., that having been done both in 1925 and 1926. Tintic Standard follows the same practice, the 30c. extra paid this month duplicating the one paid last January. United Gold's dividend record has been irregular. Wright-Hargreaves has decided to pay quarterly dividends on the first of February, May, August, and November, instead of a month earlier as heretofore, so as to have more complete information on the company's earnings for the various quarters of the calendar year before dividends are declared.

Some Companies Reduce Payments

Consolidated Lead & Zinc, operating in the Tri-State district, and a subsidiary of Eagle-Picher, reduced its quarterly dividend from 62½c. to 12½c., following partially suspended operations at the lower prices for concentrates. Ahumada Lead paid 15c. instead of 25c., which was the rate of the preceding seven quarters. Lower prices of lead and silver are no doubt responsible. Its subsidiary, Erupcion, paid 10c. as usual. Lucky Tiger-Combination has also suffered from lower silver prices and paid only 5c. instead of the usual 7c. monthly distribution. Silversmith, a silver-lead-zinc property in British Columbia, which had been paying 2c. quarterly, passed its dividend and is reported to have closed down awaiting better metal prices and the development of more ore. Nothing has been heard from Utah-Apex, a regular dividend payer last year, with a distribution of 25c. to its credit in October.

Market Yields Show Wide Range

Erupcion, at current market prices, offers the greatest yield of any of the mining stocks quoted—40 per cent. Presumably its ore is about exhausted. Plutus, a small Utah property, comes next, followed by Gladstone Mountain, a still smaller though prosperous lead producer in Washington. On the low end of the scale is Newmont Mining, purely a holding company, which has been rather fortunate in some of its investments; its stock yields only 3½ per cent. Consolidated Mining & Smelting, including its bonuses, yields only 4, so increased dividends are evidently expected. Its remarkably productive Sullivan mine is a highly profitable property. It has recently increased its electrolytic zinc production, on which an excellent profit must be made with high-grade zinc at 9c. per lb., and its fine technical staff is exerting a maximum of effort to reduce costs and increase the amount and variety of the products of the Trail smelter.

Among the other companies mentioned in the table, Cresson Consolidated re-

Mining Dividends for January, 1927

Companies in the United States	Situation	Per Share	Total	Per Cent Annual Yield
Aluminum Company of America, pfd	Various	$1.50 Q	$1,104,570	5.9
Arizona Commercial Mining, c	Arizona	0.50 SA	132,500	10.2
Bingham Mines, s,l	Utah	1.00 Q	50,000	9.7
Bunker Hill & Sullivan, l, s	Idaho	0.75 M	245,250	....
Chief Consolidated, l,s	Nev.	0.10 Q	114,185	14.0
Cleveland-Cliffs Iron	Mich.	1.00 Q	400,000	....
Consolidated Lead & Zinc	Kans.	0.125 Q	25,000	....
Cresson Consolidated Gold	Colo.	0.10 Q	122,000	15.2
Eagle-Picher Lead, pfd., l,z	Okla., Mo.	1.50 Q	12,769	6.0
Gladstone Mountain, l	Wash.	0.005 M	6,609	j25.0
Homestake Mining, g	S. D.	1.50 MX	376,740	j11.1
Inland Steel, pfd	Minn.	1.75 Q	175,000	6.3
Inspiration Consolidated Copper	Ariz.	0.50 Q	590,983	8.2
Kennecott Copper	Alaska	1.25 Q	5,620,754	8.1
Magma Copper, c,s	Ariz.	0.75 Q	306,116	8.8
Newmont Mining, h	Various	0.60 QZ	258,720	3.5
Nichols Copper, pfd	N. Y.	1.75 Q	40,173	....
Park Utah Consolidated, s,l,z	Utah	0.15 Q	314,025	9.8
Phelps Dodge, c	Ariz., N. M.	1.50 Q	750,000	4.6
Plutus Mining, s,l	Utah	0.15 Q	149,932	30.0
Portland Gold	Colo.	0.02 Q	60,000	15.1
Republic Iron & Steel, pfd	Various	1.75 Q	437,500	7.0
Silver King Coalition, s,l	Utah	0.25 Q	304,025	j13.8
Sloss-Sheffield Steel & Iron, pfd	Ala.	1.75 Q	117,250	6.5
Tintic Standard, s,l,c	Utah	0.30 Y	345,874	j15.4
United Gold Mines	Colo.	0.01	50,000	....
U. S. Smelting, Refining & Mining, s,l	Various	0.875 Q	307,226	10.0
U. S. Smelting, Refining & Mining, pfd	Various	0.875 Q	425,556	7.6
Virginia Iron, Coal & Coke, pfd	Va.	2.50 SA	125,000	6.2
Companies in other countries				
Ahumada Lead, l,s	Chihuahua	0.15 Q	178,803	12.6
Asbestos Corporation, pfd	Que.	1.75 Q	130,482	8.2
Consolidated Mining & Smelting, l,s,c,z	B. C.	6.25 SA	3,170,975	j 4.0
Dome, g	Ont.	0.50 Q	476,667	20.3
Erupcion, l,s	Chihuahua	0.10 Q	125,000	40.4
Frontino & Bolivia Gold	Colombia	1s.	£7,000	....
Hollinger Consolidated Gold	Ont.	$0.10 4 wks.	$492,000	5.9
Howe Sound, c,l,s	B. C., Mex.	1.00 Q	496,038	10.4
Lucky Tiger-Combination, g,s	Sonora	0.05 M	35,767	10.0
Mining Corporation of Canada, s	Ont.	0.125 SA	207,506	7.6
N. Y. & Honduras Rosario, g,s	Honduras	0.50 Q	100,000	18.2
Nipissing, s	Ont.	0.15 Q	180,000	5.9
Premier Gold, s,g	B. C.	0.08 Q	400,000	17.1
San Francisco Mines, l,z,s	Chihuahua	2s. 6d.	£187,994	....
Santa Gertrudis, g,s	Hidalgo	9d.	$56,875	....
Total and average			$18,960,995	11.6

c, copper; s, silver; l, lead; z, zinc; g, gold; h, holding company; Q, quarterly; SA, semi-annually; M, monthly; X, includes $1 extra; Y, extra; Z, plus 5 per cent stock dividends; j, based on dividends for the last twelve months.

ports a production for the fourth quarter of the calendar year 1926, of 29,996 tons of ore, of a gross value of $15.57 per ton, on which the net returns were $156,242. The company had $1,062,056 cash on hand on Dec. 31. Dome has warned stockholders that future dividends may be paid only as justified by earnings. Ore is reported as getting short at this property, though some favorable development was reported a month or two ago. Gold production in December amounted to $317,709; for 1926 it was valued at $3,922,794, and for 1925, $4,358,845. Income before allowing for depreciation and depletion was $428,337 for the fourth quarter of 1926, compared with $528,411 for the same period in 1925. For the year 1926 it was $1,742,760, compared with $2,053,008 in 1925.

Mining Corporation produced 537,923 oz. of silver in the fourth quarter, the average grade of mill ore being 22½ oz.

New York & Honduras Rosario paid the same dividend that it has for the last two years. Very little of this stock is on the market. On Jan. 24, 100 shares of this stock was sold on the New York Curb for $11 a share, making the present dividend yield at the high rate of 18 per cent.

"Metal Industry" Discusses Copper and London Metal Exchange

Apropos of the functions of an open metal exchange, and paying its respects to the Copper Exporters, Inc., the *Metal Industry*, of London, says:

"Of its kind there is only one metal exchange in the world, and that is in London, for in other centers of the metal trade, whether provincial or foreign, the activities of the non-ferrous group at any rate do not as a rule 'cut much ice.' Some of the biggest copper interests in America scarcely take the trouble to put in an appearance on 'Change, knowing full well that their time can be more usefully employed elsewhere. In a word, the London Exchange stands alone in world importance, and other centers are largely subsidiary to it.

"One of the principal reasons advanced for the formation of the existing American copper combine was that foreign speculators having no financial interest in the production of the metal engineered situations on their markets unfavorable to the producers. While it is true that price movements on the London Exchange can be, and are, influenced by powerful operators, it goes without saying that economic forces must triumph, and that speedily, over any artificial manipulation.

"In view of the powerful influence exerted by London Metal Exchange quotations on buyers of copper all over the world, it must be presumed that this criticism was leveled against dealers here, and, *ipso facto*, against an institution which makes such 'unfavorable conditions' possible. Is it to be assumed, then, that a metal exchange is invariably a species of 'gambling hell,' and, therefore, inimical to the best interests of producers, whether mine owners or manufacturers? Have there not been disastrous speculative 'ramps' in metals on the American side of the Atlantic? Have we not all heard of inveterate gamblers who gambled on their way to the scaffold?

"This point has been stressed at some length in view of the tendency apparent in published articles on the copper combine to credit the American producers with a desire to destroy the standard market as something entirely opposed to their interests. There always has been speculation in warrants, and as long as the London Metal Exchange exists, it seems probable that—human nature being what it is—there always will be; but it would obviously be unjust to infer that speculation, and, arising from it, situations adverse to producing interests, exist because metal exchanges are found to be necessary and useful adjuncts to trading. Jacob was a speculator, but without the assistance of a metal exchange!"

Potash Producers in France and Germany Sign Agreement

Provisional Terms of Last April Operative for Five Years—Proportions 30 and 70 Per Cent

Competition between the German and French producers of potash is definitely ended for a period of five years, according to an agreement signed recently at Paris, under the terms of which foreign business will be divided on the basis of 70 per cent to the German and 30 per cent to the French interests.

There were previous agreements, the first dating from 1924 and applying only to sales in the United States and the second, from 1925, applying to sales all over the world—but both were provisional and in the nature of experiment. The experiment has proved its value, so that the chance of a return to the old conditions of cut-throat competition is ended.

Under the new agreement as sales increase the French proportion also increases, so that eventually, when and if the total of annual sales abroad reaches 840,000 tons, the German and French shares will be even. As for sales within each country and its colonies and dependencies, they remain reserved to each party exclusively.

In recent years the foreign sales of Franco-German pure potash have been as follows:

	Metric Tons	
	French	German
1925 (estimated)	200,000	335,000
1924	179,890	320,000
1923	156,568	350,000
1922	145,542	332,000

The internal French consumption is approximately 100,000 tons annually, against only 33,000 in 1913, a result of active campaigning; and the output of the Alsace mines now runs at about 350,000 tons. German production is double that of the French producers, and can be put at 700,000 tons of pure potash. In the case of both countries, therefore, the foreign markets are highly important, but in France the home market is capable of development, whereas in Germany this expansion is less easy.

It is noteworthy, also, that German output is now, without the Alsace mines, about the same as it was in 1913 with them.

The American market is of most importance, both to Germany and France. The percentages of their foreign sales are, respectively, 32.8 and 50. Belgium (19.5 per cent), and Great Britain (17.2 per cent) are the next most important clients of France; and of clients of Germany the principal ones are Holland, 26 per cent, and Scandinavia, 16 per cent.

It is declared that the Franco-German agreement does not concern prices, but has as its main aim the development of sales. It is true, nevertheless, that as the immediate result of the first agreement prices were raised. However, this did not depress sales, on account of the virtual monopoly of production held by the two countries.

Statistical Notes

Burma Corporation, Ltd., operating in Upper Burma, during the month of December, mined 30,390 tons of ore, including 1,861 tons of high-grade. Of this 24,300 tons of ore was concentrated, producing 8,504 tons of lead concentrate. A total of 11,621 tons of lead-bearing material, including 1,776 tons of high-grade ore, was smelted in the blast furnaces, producing 5,511 tons of hard lead for treatment in the refinery.

Refinery products were 4,700 tons of lead and 407,500 oz. of silver. Of the silver production, 50,959 oz. was recovered from the treatment of copper matte. The zinc plant produced 3,900 tons of zinc concentrates, assaying 12.6 oz. of silver, 6 per cent lead, and 46.9 per cent zinc. In addition, 910 tons of copper matte was produced from the treatment of accumulated smelter by-products, and 4,000 tons of copper ore.

McIntyre Porcupine Mines, Ltd., operating in the Porcupine district in northern Ontario, did not do quite so well as to gross recovery in the last quarter of 1926 as in the preceding quarter. However, results for the last six months of 1926 surpassed those of the corresponding period of a year ago, as shown in the accompanying table.

Earnings Statement McIntyre Porcupine Mines

	Quarter Sept. 30, 1926	Quarter Dec. 31, 1926	Totals Both Quarters	Same Period Last Year	Increase
Gross recovery	$963,799.99	$936,755.51	$1,900,555.50	$1,832,806.61	$67,748.89
Costs, including development	519,979.35	539,347.07	1,059,326.42	1,057,971.98	1,354.44
Operating earnings	$443,820.64	$397,408.44	$841,229.08	$774,834.63	$66,394.45
Non-operating revenue	25,990.04	25,248.81	51,238.85	49,013.04	2,225.81
	$469,810.68	$422,657.25	$892,467.93	$823,847.67	$68,620.26
Less provision for taxes for period	20,256.70	20,739.07	40,995.77	33,641.70	7,354.07
Net earning before plant depreciation	$449,553.98	$401,918.18	$851,472.16	$790,205.97	$61,266.19

The Market Report

Lower Prices Attract Metal Buyers, Except for Copper

New York, Jan. 26, 1927—London quotations have suffered a drastic decline in the last few days, and the weakness there has been reflected on this side. At the lower prices obtaining for lead, tin, and zinc, a good business has been booked, as it was felt that the price recession was somewhat overdone. Copper sellers have maintained last week's prices for the most part; some have made slight concessions, without, however, attracting buying worthy of the name. Present prices for copper, lead, and zinc are the lowest since 1924. Silver has given a good account of itself again, keeping consistently above 56c., and antimony is slightly higher owing to expected difficulties with Chinese shipments.

Copper Market Only Nominal

A strange situation obtains in the copper market. The large producers are uniformly out of the market, generally quoting 13⅜c. in the East and 13½c. in the Middle West, at which levels no business was possible all week. Smaller sellers who make a practice of selling their current intake have shaded these prices by one-eighth cent, but even at that have been able to do practically nothing. In the last day or two copper has been offered by certain sellers rather freely at 13.20c., Valley, and even less than this has been quoted in at least one instance without getting the order. Indications are that February requirements are fairly well taken care of, though some consumers are sailing closer to the wind than that. Manufacturers, though not up to capacity, are nevertheless active, but report advance orders not coming in so well as earlier in the winter. Foreign sales of copper have been slack, and dealers have been cutting the export association's price, which continues at 13.625c., c.i.f. Hamburg.

Daily Prices of Metals

Jan.	Copper	Tin		Lead		Zinc
	Electrolytic, N. Y.	99 Per Cent	Straits	N. Y.	St. L.	St. L.
20	13.025	65.00	66.625	7.50	7.30	6.45@6.575
21	13.025	64.875	66.125	7.50	7.30@7.325	6.475@6.55
22	13.025	64.875	66.125	7.45@7.50	7.30	6.475
24	13.025	64.50	65.50	7.50	7.30@7.325	6.45
25	13.00	64.00	64.875	7.40	7.25	6.375
26	13.00	64.375	65.25	7.40	7.20	6.45@6.50
Av.	13.017	64.604	65.750	7.463	7.279	6.467

Average prices for calendar week ending January 22, 1927, are: Copper, 13.038c.; 99 per cent tin, 65.000c.; Straits, 66.479c.; N. Y. lead, 7.567c.; St. L. lead, 7.371c.; zinc, 6.525c.; and silver, 56.229c.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis; i.e., delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard.

Quotations for copper are for ordinary forms of wire bars, ingot bars, and cakes. For ingots an extra 0.05c. per lb. is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per lb.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight rate between the two points.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

Jan.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
20	55½	56¼	62⅝	299½	295	27½	27 13/16	30¾	30 11/16
21	55½	56⅜	62½	299¾	294¼	27⅜	27⅝	30 7/16	30⅜
24	55¼	55⅝	62¼	299¼	293½	26 7/16	27 3/16	29¾	29⅝
25	54⅝	55¼	62	292¼	288	26 7/16	26¾	28⅞	28⅞
26	54⅝	55¼	62	291¼	287¾	26⅜	26⅞	29⅜	29 5/16

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Jan.	Sterling Exchange "Checks"	Silver		Gold London	Jan.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
20	4.84¾	56½	26¼	84s11½d	24	4.84⅞	56¾	26 7/16	84s11½d
21	4.84⅞	56½	26⅜	84s11½d	25	4.84¾	56¼	26¼	84s10½d
22	4.84⅞	56¾	26 5/16	.....	26	4.84⅝	56½	26¼	84s11 d
					Avg.		56.542		

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-half cent premium.

New York Lead at 7.40c.

Twice during the week ending today the American Smelting & Refining Co. has reduced its official contract price for New York lead. On Thursday, Jan. 20, a cut of $3 per ton brought the price from 7.65c. to 7.50c., and on Tuesday, Jan. 25, a further cut of $2 made the price basis 7.40c. per lb. Limited quantities of metal have been available all week in the domestic market at prices somewhat under the Smelting company's figure, and this, together with continued weakness in London, is responsible for the reduction. In the Middle West 7.30c. had been the prevailing figure until yesterday, when the leading interest as well as other sellers sold at 7.25c. Today 7.20c. is the ruling price. In total volume the business of the week has been excellent, possibly exceeding the average. Large interests, however, predominated in the buying, so that the total number of transactions was not so high. Big consumers apparently feel that the price is low and that they can afford to buy ahead, much of the business being for March and April. Ammunition makers and paint manufacturers participated in the business. Incidentally, through an erroneous interpretation of the statistics, one trade paper "headlined" a 15 per cent increase in the world's production of lead for 1926. The correct figure is 6.6 per cent.

Tin Active on Break

Following a big drop in the London price and lower offerings in the domestic market yesterday, both consumers and dealers who were short bought heavily yesterday. As a consequence the price became markedly firmer before the close. There is a large tonnage of tin afloat, and for this reason near-by Straits is relatively weaker than other positions and grades of metal. Tin of 99 per cent grade for prompt delivery is less than a cent under Straits; and March Straits is at only about ¼c. discount from spot.

Zinc Touched 6.35c.

The crash of zinc prices in London on Monday and Tuesday led sellers here

to cut their prices sharply, and zinc was sold as low as 6.35c. There was a reaction today, however, with the cheapest offerings apparently at 6.45c. Sales have again been good this week, both galvanizers and brass makers being attracted by the lower prices, with deliveries scattered over January, February, and March. High-grade has so far sold at 9c., delivered in the East, but some concession from this figure is likely in view of the decline in Prime Western. Brass Special has commanded about five points premium.

Silver Closes at 56½c.

Although India and China have operated on both sides of the silver market, buying has predominated, which was reflected in the higher level of prices that prevailed during the last week. Speculative operations still play a prominent part in the market, and the future continues uncertain. The Indian Legislature is now in session at Delhi, and the bill incorporating the recommendations of the Currency Commission is up for consideration. No word has been received as yet of any action taken. The legislature's attitude regarding this bill will undoubtedly have an influence on silver.

Mexican Dollars (Old Mexican pesos): Jan. 20th and 21st, 43c.; 22nd and 24th, 43¼c.; 25th, 42¾c.; 26th, 43c.

Exchanges Weaken Slightly

The principal foreign exchanges are slightly lower than a week ago. Closing cable quotations on Tuesday, Jan. 25, were as follows: Francs, 3.94¼c.; lire, 4.29c.; and marks, 23.69¾c. Canadian dollars, 3/32 per cent discount.

Other Metals

Quotations cover large wholesale lots unless otherwise specified. London prices are according to latest mail advices.

Aluminum — Domestic or imported, 98 or 99 per cent grades, 26c. per lb.

Antimony—Per lb., duty paid, New York: Chinese brands, spot, 14¼@14½c.; April prices about ⅜c. less; Cookson's "C" grade, spot, 17½c. Market fairly good. Needle antimony nominally 8c. for lump and 10c. for powdered. White oxide, 16½c.

Bismuth—Per lb., New York, in ton lots, $2.70@$2.75. London, 10s.

Cadmium—Per lb., New York, 60c.

Iridium—Per oz., $115@$120 for 98@99 per cent sponge and powder.

Nickel — Per lb., ingot, 35c.; shot, 36c.; electrolytic, 39c. (99.75 per cent grade). Contracts for 1927 with principal consumers reported on 30@33c. basis. London, £170@£175 per long ton, according to quantity.

Osmium—Per oz., $55@$60.

Palladium—Per oz., $58@$63. Pure metal as a constituent of crude platinum, $53@$55 per oz. London, £11@£12, nominal.

Platinum — Official price on refined metal, $110 per oz. Open market cash sales of large lots, $100@$103. Pure metal as a constituent of crude platinum, $97@$98. Market very dull.

London, £22 per oz. for refined and £20 for crude. Dull.

Quicksilver—Per 75-lb. flask, $101@$102 for spot, depending upon quantity. San Francisco wires $99.33, steady. London, £17@£17¼.

Rhodium—Per oz., $55@$60, nominal; London, £10.

Ruthenium—Per oz., $40@$45, nominal; London, £7½.

The prices of Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Monel Metal, Radium, Selenium, Tellurium, Thallium, Tungsten, and Zircon are unchanged from the issue of Jan. 8.

Metallic Ores

Manganese Ore—Per long ton unit of Mn, c.i.f. North Atlantic ports, minimum 47 per cent Mn, 36@38c. Caucasian (washed), 53@55 per cent, 38@40c. Chemical grades unchanged from Jan. 8 issue.

Tungsten Ore — Per unit of WO_3, N. Y.: Wolframite, $11@$11.25; Western scheelite, $11.50@$11.75. Market firm on small business.

Chrome, Iron, Molybdenum, Tantalum, Titanium, Uranium, and Vanadium Ores are unchanged from quotations in the Jan. 8 issue.

Zinc-Lead Prices Again Lowered

Joplin, Mo., Jan. 22, 1927

Blende

High	$48.80
Premium blende, basis 60 per cent zinc	$43.00@ 44.00
Prime Western, basis 60 per cent zinc	42.00
Fines and slimes, 60 per cent zinc	41.00@ 39.00
Average settling price, all zinc	44.52

Galena

High	$100.50
Basis 80 per cent lead	92.50
Average settling price, all lead	$97.90

Shipments for the week: Blende, 15,752; lead, 2,354 tons. Value, all ores the week, $939,170.

One company with fourteen mines has all idle but four. The output is now around 3,300 tons below the average of last year, and approximately 5,000 tons less than the peak production of the year. Price offerings today were lowered an additional $2 per ton, to the $42 basis for Prime Western grades of blende. This action was despite the fact that the cost shown in the operation of 75 mills, grinding 624,615 tons of ore and producing 42,777 tons of concentrate, was $45.26 per ton of concentrate in November, according to statistics compiled by the Tri-State Zinc and Lead Ore Producers' Association.

Platteville, Wis., Jan. 22, 1927

Zinc Blende	Per Ton
Blende, basis 60 per cent zinc	$46.75
Lead Ore	
Lead, basis 60 per cent lead	$92.00

Shipments for the week: Blende, 1,355 tons; lead, 40 tons. Shipments for the year: Blende, 4,432; lead, 100 tons. Shipments for the week to separating plants, 2,302 tons buende.

Non-Metallic Minerals

Amblygonite, Asbestos, Barytes, Bauxite, Borax, Celestite, Chalk, China Clay, Diatomite, Emery, Feldspar, Fluorspar, Fullers Earth, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Iron Oxide, Lepidolite, Limestone, Magnesite, Mica, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystal, Silica, Spodumene, Sulphur, Talc, Tripoli, and Zircon are unchanged from prices in the Jan. 8 issue.

Mineral Products

Arsenious Oxide (White Arsenic)—3½@3¾c. per lb. Quiet.

Copper Sulphate—Good demand and small stocks held by producers has caused market to advance to about 4.80c. per lb.

Calcium Molybdate, Sodium Nitrate, Sodium Sulphate (Salt Cake), and Zinc Oxide are unchanged from prices in the Jan. 8 issue.

Ferro-Alloys

Ferromanganese—Domestic and foreign, 78@82 per cent, $100 per long ton, furnace or duty paid, for delivery during first half of 1927. Spiegeleisen, 19@21 per cent, $36@$37, f.o.b. furnace; 16@19 per cent, $34@$35.

Ferrocerium, Ferrochrome, Ferrophosphorus, Ferrosilicon, Ferrotitanium, Ferrotungsten, Ferro-uranium and Ferrovanadium are unchanged from prices in the Jan. 8 issue.

Metal Products

Rolled Copper—Sheets, 21¾c.; wire, 15½c., f.o.b. mill.

Lead Sheets—Full rolled, 11c. per lb.; clipped, 11½c.

Nickel Silver—28¾c. per lb. for 18 per cent nickel Grade A sheets.

Yellow (Muntz) Metal—Dimension sheets, 19½c. per lb.; rods 16½c.

Zinc Sheets—11c. per lb., f.o.b. mill.

Refractories

Silica Brick—Pennsylvania prices reduced to $40 per M.

Chrome Brick, Fireclay Brick, Magnesite Brick, and Zirkite are unchanged from quotations in the Jan. 8 issue.

Steel Trade Shows Improvement —Prices Easier

Pittsburgh, Jan. 25, 1927

The volume of steel orders is slowly increasing, practically all along the line, but the whole level is well below that of a year ago, the divergence having begun about three months ago.

Mill operations have increased somewhat on the whole, and January promises to show an average rate considerably above the 74 per cent rate reported for December. The 89 per cent rate of last January is not being closely approached.

In a few lines prices are easier. Black sheets have lost another dollar a ton, sales being generally at 2.85c. to 2.90c. Galvanized and blue annealed sheets have lost little more ground.

Pig Iron—Pig-iron prices remain quotable at $19.50 for Bessemer, $18 for basic and $18.50 for foundry, f.o.b. Valley furnaces.

Connellsville Coke.—Spot prices are yielding slightly. Spot furnace, $3.25; spot foundry, $4.50@$5.

Current Prices of Mining Supplies

Rise and Fall of the Market

STEEL used in mine construction and maintenance shows slight weakness, although current prices of some of the items are above those of a month ago. Hand-to-mouth buying is probably responsible for the present keen competition for available tonnages. The pipe market is seasonably dull, with possibilities of early resumption best in cast-iron pipe. Mine timbers are moving slowly, with no price developments either in an upward or downward direction. Rains, flood and seasonal slackness affect the current lumber market, particularly in the South and Southwest.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh, Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$2.25@2.40	$3.60	$3.50	$4.00	$3.89
Black No. 24	3.10@3.15	4.45	3.95	4 90	4.35
Galvanized No. 24	3.75@3.85	5.25	4.80	5.90	5.10

STEEL RAILS—The following quotations are per ton f.o.b. Pittsburgh and Chicago for carload or larger lots:

	Pittsburgh Current	Pittsburgh One Year Ago	Birmingham	Chicago
Standard bessemer rails	$43.00	$43.00	$43 00	$43.00
Standard openhearth rails	43.00	43.00	43.00	43.00

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh for carload lots, together with the warehouse prices at the places named:

	Pittsburgh Current	Pittsburgh One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅝-in. and larger	$2.80–2.90	$2 80	$3.55	$3 65	$4.35	$3.00
Track bolts	3.90–4.25	3.90@4.15	4.55	4.60	5.85	3.90
Standard section angle bars	2.85	2.75	3.40	3.75	3.60	4.15

STRUCTURAL MATERIAL—Following are base prices in carload lots, f.o.b. mill, Pittsburgh and Birmingham together with quotations per 100 lb. in less than carload lots, from warehouses at places named:

	Pittsburgh, Mill	Birmingham Mill	New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	$2 00	$2.05	$3.34	$4.15	$3.25	$3.10	$3.30
Channel, 3 to 15 in.	2.00	2.10	3.34	4.15	3.25	3.10	3.30
Angles, 3 to 6 in., ¼ in. thick	2.00	2.10	3.34	4.15	3.25	3.10	3.30
Tees, 3 in. and larger	2.00	2.10	3.34	4.15	3.35	3.10	3 30
Plates ¼-inch thick	1.90	2.00	3.34	4.15	3.25	3.10	3.30

WIRE ROPE—Discounts from list price, f.o.b. New York and east of Missouri River, on regular grades of bright and galvanized are as follows:

Cast steel round strand rope	20%
Galvanized steel rigging and guy rope	7½%
Round strand iron and iron tiller	5%
Plow steel round strand rope	35%
Special steel round strand rope	30%
Galvanized iron rigging and guy rope	+12½%

	New York	Cleveland	Chicago
Drill Rod (from list)	60%	55%	50%

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

	Steel Inches	Steel Black	Steel Galv.	Iron Inches	Iron Black	Iron Galv.
BUTT WELD—	⅛ to 3	62	50½	⅛ to 1½	30	12
LAP WELD—	2½ to 6	59	47½	3 to 6	28	13

STEEL PIPE—From warehouses at the places named the following discounts hold for steel pipe:

	Black New York	Black Chicago	Black St. Louis
2½ to 6 in. lap welded	48%	51%	46%

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	New York Current	New York One Year Ago	Birmingham	Chicago	St. Louis	San Francisco
6 in. and over	$48.60	$51.60@52.60	$38.00 base	$46.20	$44.60	$48.00

NUTS—Semi-finished, ½x½-in., 2c. each. Discount 70% for ⅝-in. and smaller; 65% for ¾-in. and larger. Case hardened, 6c. each, less 50%.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York Current on Trucks	New York One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco	Perth Amboy N. J., Factory
4x12x12	$0.1027	$0.1112	$0.076	$0.105	$0.068	$0.108	.....
6x12x12	.1541	.1667	.104	.....	.09	.156	$0.252*
8x12x12	.1926	.2084	.142	.205	.126	.244	.312†

* 10x12x12; † 12x12x12.

MACHINE BOLTS—½x1½-in., per 100, $1.70. Discount at New York warehouses on all sizes up to 1x30-in., 40%.

LUMBER—Prices of rough Douglas Fir No. 1 common, in carload lots to contractors at yards in San Francisco.

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft
3x3 and 4	$26.00	$27.00	$28 00	$31.00
3x6 and 8	26.00	27.00	28.00	31.00
4x4-6 and 8	26.00	27.00	28.00	31.00

Wholesale prices to dealers of long leaf yellow pine. To contractors in New York City, delivered from lighters or cars to job, $5 additional.

	New York 20 Ft. and Under	New York 22-24 Ft.	Chicago Up to 20 Ft., Pine	Chicago Up to 32 Ft., Fir
3x4 to 8x8	$43.00@44.00	$44.00@45.00	$40.00	$40.00
3x10 to 10x10	50.00@51.00	51.00@52.00	47 00	40 00
3x12 to 12x12	57.00@58.00	58.00@59.00	56.00	40.00

Other Cities	8 x8-In. x 20 Ft. and Under Pine	Fir*	Hemlock	Spruce	12 x 12-In. 20 Ft and Under Pine	Fir*
Boston	$48.50	$48.00†	$50.00	$51.00	$58.50	$58.00†
Cincinnati	37.00	73 00	73.00	85 00	48.00	77.00
Denver	.....	32 75	32.75	32.75	....	34.75
Minneapolis	42 50	39.25	34.50	.....	45 00	39.25
Kansas City, Mo.	42.50	40 75	.....		57.50	40.75
Philadelphia	54.00	38.00	38.00	45.00	65.00	38.00

*Douglas fir. † Prime.

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh, Mill	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.65	$3.05	$3.50	$4.25	$2.83	$4.95
Cut	2.80	....	5.25	5.00	2.93	5.00

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots *without bags*. Cash discount not deducted.

	Current	One Month Ago	One Year Ago
New York, del. by truck	$2.50@2.60	$2.50@2.60	$2.50@2.70
Chicago, f.o.b.	2.10	2.10	2.10
Cleveland, f.o.b.	2 29	2.29	2.29

LIME—Warehouse prices, New York quotes 280 lb. net; Chicago, 180 lb.:

	Hydrated, per Ton Finishing	Hydrated, per Ton Common	Lump, per Barrel Finishing	Lump, per Barrel Common
New York	$18.20	$11.00	$3.50	$2.10@$3.00
Chicago	20.00	18.00	....	1.50

LINSEED OIL—These prices are per gallon:

	New York Current	New York One Year Ago	Chicago Current	Chicago One Year Ago
Raw in barrel (5 bbl. lots)	$0.84½	$0.99	$0.84	$0.99

WHITE AND RED LEAD—In 100-lb. kegs, base price in cents per pound:

	Dry Current	Dry 1 Yr. Ago	In Oil Current	In Oil 1 Yr. Ago
Red	15.25	15.25	16.75	16.75
White	15.25	15.25	15.25	15.25

HOSE—Quotations at New York warehouses:

Fire Protection 50-Ft. Lengths
Underwriters' 2½-in. coupled, single jacket (net) ..... $0.68 per ft.

Air—Best Grade
¾-in., per ft. ..... 3 ply $0.34 4 ply $0.42

Steam—Discounts from List
First grade .... 40% Second grade ..... 40–5% Third grade 50%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. for rubber transmission belting.
Best grade ..... 50% Second grade 50–10%

LEATHER BELTING—List price, 24c. per lin.ft. per inch of width for single ply at New York warehouses:

Grade	Discount from list
Medium	40–5%
Heavy	30–10%

RAWHIDE LACING
For cut, best grade, 50%, 2nd grade, 60%.
For laces in sides, best, 41c. per sq.ft.; 2nd, 37c.
Semi-tanned: cut, 50%; sides, 41c. per sq.ft.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam, ½ in.	$1 05
Rubber sheet	.60
Rubber sheet, wire insertion	.85

MANILA ROPE—Per lb., ¾-in. and larger, 1,200-ft. coils.

Atlanta	$0.30	New Orleans	$0 21
New York	24½	Seattle	22
Chicago	23½	San Francisco	22

EXPLOSIVES—Prices per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.265	$0.2875
Minneapolis	.1917	2123
Denver	.2025	2275
Seattle	.165	.19
Cincinnati	.22	.245
New Orleans	235	.26
San Francisco	.1625	.1925

FLOTATION OIL—

Pine tar, 50 gal. bbl., gross weight 500 lb., f.o.b. New York, carload lots, per gal.	$0.46

CHEMICALS—

Zinc dust, 550 lb. casks, f.o.b. works, per lb.	$0.10@.10½
Litharge, casks, f.o.b. works, per lb.	.11
Sodium cyanide, 220 lb. single case lots, f.o.b. works, per lb.	18@.22
Calcium carbide, in drums, f.o.b. works, per lb.	05½@.06

Mining Stocks—Week Ended January 15, 1927

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda	New York	49⅛	47⅝	48⅜	Ja. 15, Fe. 21	Q 0.75
Arcadian Consol.	Boston	*80	*80	*80		
Ariz. Com'l	Boston	10	9⅜	9⅜	Ja. 7, Ja. 28	0.50
Calaveras	N. Y. Curb	...	...	1⅞		
Calumet & Arizona	New York	67½	66½	66¾	De. 3, De. 20	Q 1.50
Calumet & Hecla	Boston	15	14¾	14¾	No.30, De.15	0.50
Cerro de Pasco	New York	62⅜	60⅞	61½	Ja.13,Fe 1, Q	1.00
Chile Copper	New York	36⅛	34⅜	36	De.1,De.27, Q	0.62½
Chino	New York	...	...	22⅛		
Con. Coppermines	N. Y. Curb	3	2⅞	2⅞		
Copper Range	Boston	14⅞	13⅛	14⅛	May, 1926	1.00
Crystal Copper	Boston Curb	*32	*27	*30		
East Butte	Boston	2½	2½	2½	Dec., 1919	0.50
First National	Boston Curb	*9	*9	*9	Feb., 1919	0.15
Franklin	Boston	...	...	*20		
Granby Consol.	New York	34⅞	33½	33⅝	May, 1919	1.25
Greene-Cananea	New York	30½	29⅝	29¾	Nov., 1920	0.50
Hancock	Boston	*75	*50	*75		
Howe Sound	New York	39	38	38⅞	De.31, Ja.15	Q 1.00
Inspiration Consl.	New York	25⅛	24⅛	24⅝	De.16, Ja.3,	Q 0.50
Iron Cap	Boston Curb	2⅞	2⅞	2⅞		
Isle Royale	Boston	10¼	10	10¼	No. 30, De. 15	0.50
Jerome Verde Dev	N. Y. Curb	*39	*39	*39		
Kennecott	New York	61⅞	61⅜	61⅜	De. 3, Ja. 2	Q 1.25
Lake Copper	Boston	...	...	*80	June, 1925	0.50
Magma Copper	New York	35⅛	34⅛	35	Dec. 1, Ja.15,	Q 0.75
Mason Valley	N. Y. Curb	2⅛	2	2		
Mass Consolidated	Boston	*50	*50	*50	Nov., 1917	1.00
Miami Copper	New York	16	15⅜	16	Fe.1, Fe. 15	Q 0.37½
Mohawk	Boston	41½	39⅛	39⅜	Ja.29, Ma 1	Q 1.00
Mother Lode Coa	New York	4½	4⅛	4⅛	De.10,De.31	SA 0.37½
Nevada Consol.	New York	15	14⅛	15	De.15, De.31	Q 0.37½
New Cornelia	Boston	23⅜	22⅞	23	No.5, No.22	Q 0.50
Noranda	N. Y. Curb	23⅜	22	22⅛		
North Butte	Boston	3⅛	3	3⅛	Oct., 1918	0.25
Ohio Copper	N. Y. Curb	*49	*46	*46	Se. 1, Se. 15	0.03
Old Dominion	Boston	14⅜	14⅛	14⅛	Dec., 1918	1.00
Phelps Dodge	Open Mar.	†132	†128	...	De.24, Ja.3	Q 1.50
Quincy	Boston	16⅛	15	16	Mar., 1920	1.00
Ray Consolidated	New York	15¼	15	15¼	Ap.20, Ap.30	0.25
St. Mary's Min. Ld.	Boston	24	23	24	May, 1926	2.00
Seneca Copper	New York	3⅜	3⅛	3⅜		
Shannon	Boston	*40	*25	*25	Nov., 1917	0.25
Shattuck-Denn	Boston Curb	5⅜	4⅞	5⅛		
Superior & Boston	Boston	*31	*30	*30		
Tenn. C. & C.	New York	13⅛	11⅛	12⅜	No.30, De.15,	Q 0.25
United Verde Ex	N. Y. Curb	23⅜	22⅞	23	Ja. 6, Fe. 1	0.75
Utah Copper	New York	113¾	113¼	113¾	De.15,De.31	Q 1.50
Utah Metal & T	Boston	1⅛	1⅛	1⅛	Dec., 1917	0.30
Victoria	Boston	*85	80*	*80		
Walker Mining	Salt Lake	...	...	*72		
NICKEL-COPPER						
Internat. Nickel	New York	43⅜	40½	41	De.16, De.31,	Q0.50
Internat. Nickel, pfd.	New York	105	105	105	Ja. 13, Fe.1,	Q 1.50
LEAD						
Gladstone Mtn	Spokane	*28	*27½	*28	Ja. 1927	0.005
National Lead	New York	168	164⅜	165½	De.10, De.31	Q2.00
National Lead pfd.	New York	118	117½	117⅞	No.19,De.15	Q1.75
St. Joseph Lead	New York	42⅛	41¼	42⅛	Ma.10, 21	XQ 0.75
ZINC						
Am. Z. L. & S	New York	9⅜	8⅜	8⅜	May, 1917	1.00
Am. Z. L. & S, pfd.	New York	48⅜	43⅜	43⅜	Nov., 1920	1.50
Butte C. & Z	New York	4⅝	4½	4½	De.9, De.24	0.50
Butte & Superior	New York	11	11	11	De.9, De.24	Q 0.50
Callahan Zn-Ld	New York	2⅛	1⅞	2⅛	Dec., 1920	0.50
Eagle-Picher	Cincinnati	28	27⅜	27⅜	No.15, De.1	Q 0.40
Eagle-Picher, pfd.	Cincinnati	...	...	100	De.31, Ja.15	Q 1.50
New Jersey Zn.	N. Y. Curb	194¾	189	190	No.20, De.10	X 2.00
United Zinc	N. Y. Curb	...	...	55		
Yellow Pine	Los Angeles	*23	*20	*20	Dec. 1925	Q 0.04
GOLD						
Alaska Juneau	New York	1⅜	1⅛	1⅜		
Argonaut	Toronto	*54	*51	*51		
Barry-Hollinger	Toronto	*99	*83	*97		
Carson Hill	Boston	...	...	*10		
Consol. W. Dome L.	Toronto	*17	*12½	*16½		
Cresson Consol. G.	N. Y. Curb	2⅝	2⅝	2⅝	De.31, Ja.10	Q 0.10
Crown Reserve	Toronto	*10¼	*9⅜	*10	Jan., 1917	0.05
Dome Mines	New York	10⅜	9⅞	9⅞	De.31, Ja.30,	Q 0.50
Golden Center	N. Y. Curb	1⅝	1⅜	1⅜		
Golden Cycle	Colo Springs	†1.76½	†1.74	....	No.30, De.10	Q 0.04
Hollinger Consol.	Toronto	20.85	20.45	20.50	Ja.12, Ja.28	0.10
Homestake Mining	New York	63¼	63	63	Ja.20,Ja.25	MX 1.50
Kirkland Lake	Toronto	*95	*90	*94		
Lake Shore	Toronto	17.15	16.01	17.15	De.2,De.15	X 0.20
McIntyre-Porcupine	New York	26½	25⅞	25⅞	Fe.1, Ma.1	Q 0.25
Newray	Toronto	*31	*31	*31		
Night Hawk Pen	Toronto	*5½	*4½	*5		
Portland	Colo Springs	†*55	†*52	....	Ja.6, Ja.15, '27	0.02
Rand Mines	New York	...	...	9½	Au.23-30	Am.Sh. 1.52
Teck-Hughes	Toronto	6.80	5.95	6.50	Ja.31, Fe. 1	0.05
Tom Reed	Los Angeles	*51½	*51	*51½	Dec., 1926	0.02
Tough-Oakes	Toronto	*61	*56	*61		
United Eastern	N. Y. Curb	*53	*50	*50	July, 1924	0.05
Vipond Cons	Toronto	1.66	1.60	1.63		
Wright-Hargreaves	Toronto	9.97	9.40	9.80	Ja15,Fe.1	QX 0.15
Yukon-Alaska Trust	N. Y. Curb	....	....	20½		
GOLD AND SILVER						
Carnegie Metals	Pittsburgh	11⅞	11⅜	11⅜		
Con. Cortes	N. Y. Curb	*8	*7	*7		
Con. Virginia	San Francisco	*7⅛	*7⅛	*7⅛		
Continental Mines	N. Y. Curb	...	...	*15		
Dolores Esperanza	N. Y. Curb	...	...	*50	July, 1923	0.05
Premier Gold	N. Y. Curb	1⅛	1⅛	1⅛	De.17, Ja.4	Q 0.08
San Rafael	San Francisco	...	...	*28		
Tonopah Belmont	N. Y. Curb	2⅜	2¼	2¼	Se.15, Oc.1	0.05
Tonopah Extension	N. Y. Curb	*28	*25	*28	Apr. 1925	0.05
Tonopah Mining	N. Y. Curb	3⅜	3⅜	3⅜	Se.30, Oc.21	SA 0.07½
West End Consol.	N. Y. Curb	*9	*8	*9	Mar., 1923	0.05
Yukon Gold	N. Y. Curb	...	...	*40	June, 1918	0 02

Stock	Exch.	High	Low	Last		Last Div.
SILVER						
Beaver Consol	Toronto	*75	*72	*73½	May. 1926	0.03
Canadian Lorrain	Toronto	*59	*54	*57		
Castle-Trethewey	Toronto	1.08	1.02	1.07		
Coniagas	Toronto	4.35	4.20	4.20	May, 1924	0.12½
Keeley	Toronto	1.54	1.49	1.52	Se. 1, Se.15	SA 0.12
Kerr Lake	N. Y. Curb	*80	*76	*80	Oc. 1, Oc.15	SA 0.12½
La Rose	Toronto	*12	*12	*12	Apr., 1922	0.10½
Lorrain Trout Lake	Toronto	...	...	*55	July, 1925	0.05
McKinley-Dar.-Sav	Toronto	*13¾	*12	*13½	Oct., 1920	0.03
Mining Corp. Can	Toronto	3.30	3.10	3.15	De.30, Ja.15	0.12½
Nipissing	N. Y. Curb	9¼	8⅝	8⅝	De.31, Ja.20	Q 0.15
Temiskaming	Toronto	...	...	*5½	Jan., 1920	0.40
SILVER-LEAD						
Ahumada	New York	5	4⅜	5	De.18,Ja.5,	QX 0.15
Bingham Mines	Boston	41½	37¼	41	De.30, Ja.5	Q 1.00
Cardiff M. & M	Salt Lake	*49	*45	*48	Nov., 1924	0.10
Chief Consol	Salt Lake	2.85	2.75	2.85	Oc.10, No.1	Q 0.10
Consti'n Mng.&Mill'g	Spokane	*30	*28	*28		
Erupcion	Boston Curb	1	*99	*99	De.18, Ja.3,	Q 0.10
Federal M. & S	New York	90	89	90		
Federal M. & S., pfd.	New York	77	76	77	No.24, De.15	Q 1.75
Hawthorne Mines	N. Y. Curb	*10	*8	*9		
Hecla Mining	N. Y. Curb	*15	*14½	*15	No.15,De.15	Q 0.50
Highland-Surprise	Spokane	*20¼	*15	*18		
Iron King Mining	Salt Lake	*30	*30	*30		
Keystone Mining	Salt Lake	...	...	*30	Au.12, Au.26	0.07½
Lucky Jim	Spokane	*16½	*16	*16		
Lucky Tiger-Com	Kansas City	†6.60	†5.75	...	Dec. 20, 1926	0.12
Mammoth Mining	Salt Lake	...	...	2.60	De.17, De.23,	Q 0.25
Marsh Mines	Spokane	*2	*2	*2		
Park Utah	New York	6.15	6.00	6.00	De.15, Ja.2	Q 0.15
Plutus Mining	Salt Lake	...	...	2.00	Ja.10, Ja.15	Q 0.10
Prince Cons	Salt Lake	...	...	*1½		
Silver King Coal	Salt Lake	7.95	7.65	7.95	De. 16, Ja.3	0.25
Silversmith	Spokane	*29	*26	*27½	Oc.1, Oc.10	Q 0.02
Strattons Mines	Spokane	*30	*26	*30		
Sunshine M. Co	Spokane	*41⅞	*39⅜	*40		
Tamarack-Custer	Spokane	*46	*42½	*42½	Sept., 1924	0.25
Tintic Standard	Salt Lake	11.00	10.75	11.00	De.11, Ja.3	0.30
Utah-Apex	Boston	6⅞	6⅜	6⅜	Oc.3, Oc.15	Q 0.25
IRON						
Bethlehem Steel	New York	47¾	46⅝	47½	July, 1924	1.25
Cleveland-Cliffs Iron	Cleveland	77	70	75	Ja.15, Ja.25	Q 1.00
Colorado Fuel & Iron	New York	46⅛	44⅜	44⅜	May, 1921	0.75
Gt. North'n Iron Ore	New York	20⅜	19⅜	20⅜	Dec.6, Dec.28	0.75
Inland Steel	New York	43¼	42⅜	42⅜	No. 15, De.1	Q 0.62½
Mesabi Iron	N. Y. Curb	99	96	96		
Replogle Steel	New York	13⅜	12⅛	12⅛		
Republic I. & S	New York	63⅜	58¼	62½	No.15, De.1	Q 1.00
Republic I. & S. pfd.	New York	99⅝	97¼	99¼	De.15, Ja.2	Q 1.75
Sloss-Sheffield S. & I.	New York	131½	129	129	De.10, De.20	Q 1.50
Sloss-Shef. S.&I. pfd.	New York	107½	107	107½	De.20, Ja.3	Q 1.75
U. S. Steel	New York	159⅜	156⅜	157½	De.1, De.30	Q 1.75
U. S. Steel pfd	New York	130⅜	130	130⅜	No.2, No.29,	Q 1 75
Virginia I. C. & C.	New York	...	...	49½	Jan., 1924	1.50
Virginia I.C.&C.pfd	New York	...	...	80½	De.15, Ja.2,	2.50
DIAMONDS, PLATINUM, ALUMINUM, VANADIUM, TIN						
De Beers Consol	New York	...	...	32⅜	Ju.16, Ju.17	1.70
So. Am. Gold & P	N. Y. Curb	3⅛	3⅛	3⅜		
Alum.Co.of Amer	N.Y.Curb	71⅛	70⅛	70⅛		
Alum. Co. of Amer pf.	N.Y.Curb	102	101½	102	De.15, Ja.15	Q 1.50
Vanadium Corp	New York	38⅜	38⅛	38⅛	De.1, De.15,	X1.00
Patino M. & E	N. Y. Curb	25¼	25	25	Nov. 5, 1926	5 sh.
ASBESTOS						
Asbestos Corp	Montreal	24	23½	23¾	Jan., 1926	1.50
Asbestos Corp., pfd.	Montreal	83	83	83	De.31, Ja.15,	Q 1.75
SULPHUR						
Freeport Texas	New York	40⅛	36¾	38⅛	Ja.15, Fe.1	Q 0.50
Texas Gulf, new	New York	52¾	50½	51⅜	De.1, De.15,	Q 1.00
MINING, SMELTING, REFINING AND GENERAL						
Amer. Metal	New York	43⅜	42⅜	42⅞	No.19, De. 1,	Q 1.00
Amer. Metal pfd	New York	110⅛	109	110¼	No.20, De.1	Q 1.75
Amer. Sm. & Ref	New York	142⅛	138	138	Ja.14, Fe.1,	Q 2.00
Amer. Sm.&Ref.pfd.	New York	121⅛	121	121¼	Fe.4, Ma.1,	Q 1.75
Consol. M. & S	Montreal	2.54	2.48	2.49	De.31, Ja.15	X6.25
Federated Metals	N. Y. Curb	12⅛	12⅛	12⅛		
Newmont Mining	N. Y. Curb	69	67	68⅞	De.31, Ja.17,	0.60
U. S. Sm. R. & M.	New York	35	33⅞	34	Ja.6, Ja.15,	Q 0.87½
U. S. Sm. R.&M.pfd.	New York	46½	46	46	Ja.6, Ja.15,	Q 0.87½

* Cents per share. † Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. F, four weeks. I, Initial. X, Includes extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.; Spokane, Pohlman Investment Co.; Salt Lake, Stock and Mining Exchange; Henry Sachs, Colorado Springs, Colo.

LONDON QUOTATIONS—WEEK ENDED JAN. 4, 1927

Name	High	Low	Last	Last Div. Date	Amount
Aramayo Mines (25 frs.)	76/3	74/4½	75/—	Aug. 1926	15 p.c.†
British Platinum (£1)	3/9	2/10½	3/6	Feb. 1925	2½ p.c.
Burma Corpn. (10 rupees)	15/1½	14/4½	14/7½	Feb. 1927	6 annas*
Bwana M'Kubwa (5s)	7/—	6/7½	6/10½		
Camp Bird (2s)	3/6	2/4½	2/6		
El Oro (£1)	4/—	3/4½	3/9	Nov. 1924	2½ p.c.*
Esperansa (10s)	—/4½	—/3	— 3		
Frontino & Bolivia (£1)	12/6	11/3	12/6	Jan. 1927	5 p.c.
Mexican Corpn. (£1)	8/7½	7/—	8/6		
Mexico Mines of El Oro (£1)	20/—	17/6	20/—	Dec. 1926	3¾ p.c.*
N'Changa Copper Mining	16/6	14/4½	16/3		
Oroville Dredging (£1)	5/—	3/10½	4/9	Dec. 1923	3¾ p.c.
Ouro Preto (£1)	2/1½	2/—	2/—	May 1925	2½ p.c.
Rhodesian Congo Border (£1)	85/—	80/—	82/6		
St. John del Rey (£1)	9/3	9/—	9/—	June 1925	6½ p.c.
San Francisco Mines (10s)	31/10½	31/1½	31/3	Jan. 1927	25s.
Santa Gertrudis (£1)	14/6	14/—	14/3	Jan. 1927	3¾ p.c.
Selukwe (2s. 6d.)	12/3	11/9	12/—	April 1917	6¾ p.c.
S. Amer. Copper (2s.)	3/6	3/1½	3/3	Nov. 1917	75 p.c.
Tanganyika (£1)	45/3	42/7½	43/1½	Aug. 1926	7½ p.c.
Tomboy (£1)	3/4½	3/1½	3/3	July 1926	10 p.c.
Union Miniere du Haut-Katanga (Brussels)	8.540	8.400	8.400	July 1926	175 (‡)

* Free of British income tax. † Swiss frs. ‡ Belgian frs. and free of taxation

Mining Stocks—Week Ended January 22, 1927

Stock	Exch.	High	Low	Last	Last	Div.
COPPER						
Anaconda	New York	48⅜	47⅝	47⅞	Ja. 15, Fe. 21	Q 0.75
Arcadian Consol.	Boston	*78	*60	*60		
Ariz. Com'l	Boston	9½	9	9⅜	Ja. 7, Ja. 28	0.50
Calaveras	N. Y. Curb			1⅞		
Calumet & Arizona	New York	67½	66⅜	67⅞	De. 3, De. 20	Q 1.50
Calumet & Hecla	Boston	16⅛	14⅝	16½	Fe.28, Ma.15	Q 0.50
Cerro de Pasco	New York	61⅛	60⅛	61½	Ja.13,Fe.1, Q	1.00
Chile Copper	New York	36⅛	35⅛	35⅞	De.1, De.27, Q	0.62½
Chino	New York			22⅛		
Con. Coppermines	N. Y. Curb	3	2⅞	3		
Copper Range	Boston	14⅜	14⅛	14⅜	May, 1926	1.00
Crystal Copper	Boston Curb	*30	*27	*28		
East Butte	Boston	2⅛	2⅛	2⅛	Dec., 1919	0.50
First National	Boston Curb	*8	*8	*8	Feb., 1919	0.15
Franklin	Boston	*25	*25	*25		
Granby Consol	New York	34	32⅜	33	May, 1919	1.25
Greene-Cananea	New York	32⅛	29⅞	32	Nov., 1920	0.50
Hancock	Boston			*75		
Howe Sound	New York	39⅛	38⅛	39	De.31, Ja.15	Q 1.00
Inspiration Consl.	New York	25	24⅛	24⅛	De.16, Ja.3,	Q 0.50
Iron Cap	Bostor Curb	2⅜	2⅛	2⅛		
Isle Royale	Boston	11⅜	10⅜	11⅛	Fe.4, Fe.19	Q 0.50
Jerome Verde Dev	N. Y. Curb			*39		
Kennecott	New York	62	61⅛	62	De. 3, Ja. 2	Q 1.25
Lake Copper	Boston	1	1	1	June, 1925	0.50
Magma Copper	New York	35⅛	34	34⅛	Dec.1, Ja.15,Q	0.75
Mason Valley	N. Y. Curb	1⅜	1⅜	1⅜		
Mass Consolidated	Boston			*50	Nov., 1917	1.00
Miami Copper	New York	15⅜	15⅛	15⅜	Fe.1, Fe. 15	Q 0.37½
Mohawk	Boston	40⅛	40	40	Ja.29, Ma.1	Q 1.00
Mother Lode Con	New York	4⅛	4⅛	4⅛	De.10, De.31	SA 0.37½
Nevada Consol	New York	15	14⅜	14⅜	De.15, De.31	Q 0.37½
New Cornelia	Boston	24	22⅞	23⅛	Fe.4, Fe.21	Q 0.50
Noranda	N. Y. Curb	22⅛	21⅛	21⅛		
North Butte	Boston	3⅛	2⅞	3⅛	Oct., 1918	0.25
Ohio Copper	N. Y. Curb	*46	*46	*46	Se. 1, Se. 15	0.03
Old Dominion	Boston	14	13¼	14	Dec., 1918	1.00
Phelps Dodge	Open Mar.	†132	†127		De.24, Ja.3	Q 1.50
Quincy	Boston	16	16	16	Mar., 1926	1.00
Ray Consolidated	New York			15⅛	Ap.20, Ap.30	0.25
St. Mary's Min. Ld.	Boston	24⅛	24	24⅛	May, 1926	2.00
Seneca Copper	New York	3⅛	3⅛	3⅛		
Shannon	Boston			*25	Nov., 1917	0.25
Shattuck-Denn	Boston Curb	5⅜	5⅛	5⅛		
Superior & Boston	Boston			*30		
Tenn. C. & C.	New York	13⅛	12⅛	12⅛	No.30, De.15, Q	0.25
United Verde Ex	N. Y. Curb	23⅛	22⅞	23	Ja. 6, Fe. 1	0.75
Utah Copper	New York			113⅛	De.15, De.31	Q 1.50
Utah Metal & T	Boston	1⅝	1⅛	1⅜	Dec., 1917	0.30
Victoria	Boston	*65	*65	*65		
Walker Mining	Salt Lake	1.20	*80	1.10		
NICKEL-COPPER						
Internat. Nickel	New York	41⅛	39⅞	40⅛	De.16, De.31, Q	0.50
Internat. Nickel, pfd.	New York	106	105	106	Ja. 13, Fe.1, Q	1.50
LEAD						
Gladstone Mtn	Spokane	*28	*27½	*27½	Ja. 1927	0.005
National Lead	New York	167	165	165	De.10, De.31	Q 2.00
National Lead pfd	New York	118	118	118	No.19, De.15	Q 1.75
St. Joseph Lead	New York	42⅛	41⅝	41⅝	Ma.10, 21	XQ 0.75
ZINC						
Am. Z. L. & S	New York	9⅛	8⅛	9	May, 1917	1.00
Am. Z. L. & S, pfd	New York	47	43¼	46⅛	Nov., 1920	1.50
Butte C. & Z	New York	4⅜	4	4	De.9, De.24	0.50
Butte & Superior	New York	11⅜	10⅜	11	De.9, De.24	Q 0.50
Callahan Zn-Ld	New York	2⅜	2⅛	2⅛	Dec., 1920	0.50
Eagle-Picher	Cincinnati	27⅞	27⅛	27⅞	No.15, De.1	Q 0.40
Eagle-Picher, pfd	Cincinnati			100	De.31, Ja.15	Q 1.50
New Jersey Zn	N. Y. Curb	191	186⅜	187	No.20, De.10	X 2.00
United Zinc	N. Y. Curb			55		
Yellow Pine	Los Angeles	*25	*20	*25	Dec. 1925	Q 0.04
GOLD						
Alaska Juneau	New York	1⅛	1⅛	1⅛		
Argonaut	Toronto	*53⅛	*45	*47⅛		
Barry-Hollinger	Toronto	*99	*89	*89		
Carson Hill	Boston	*12	*12	*12		
Consol. W. Dome L.	Toronto	*17	*13⅜	*14⅜		
Cresson Consol. G	N. Y. Curb	3⅛	2⅝	3⅛	De.31, Ja.10	Q 0.10
Crown Reserve	Toronto	*9⅛	*8⅛	*8⅛	Jan., 1917	0.05
Dome Mines	New York	10	9⅜	9⅞	De.31, Ja.30,	Q 0.50
Golden Center	N. Y. Curb	1⅛	1⅛	1⅛		
Golden Cycle	Colo Springs	†1.76	†1.75		No.30, De.10	Q 0.04
Hollinger Consol	Toronto	20.50	20.00	20.50	Ja.12, Ja.28	0.10
Homestake Mining	New York	63	62⅛	63	Ja.20, Ja.25	MX 1.50
Kirkland Lake	Toronto	*93	*85	*87		
Lake Shore	Toronto	19.00	17.45	17.90	De.2, De.15	X 0.20
McIntyre-Porcupine	New York	25⅜	25⅛	25⅛	Fe.1, Ma.1	Q 0.25
Newray	Toronto	*30	*30	*30		
Night Hawk Pen	Toronto	*5⅛	*4⅛	*4⅛		
Portland	Colo Springs	†*54	†*52½		Ja.6, Ja.15, '27	0.02
Rand Mines	New York			9⅛	Au.23-30	Am.Sh 1.52
Teck-Hughes	Toronto	6.70	6.10	6.15	Ja.31, Fe. 1	0.05
Tom Reed	Los Angeles	*55	*50	*55	Dec., 1926	0.02
Tough-Oakes	Toronto	*62	*59	*60½		
United Eastern	N. Y. Curb	*50	*50	*50	July, 1924	0.05
Vipond Cons	Toronto	1.64	1.59	1.64		
Wright-Hargreaves	Toronto	10.00	9.55	9.70	Ja15, Fe.1	QX 0.15
Yukon-Alaska Trust	N. Y. Curb	20	20	20		
GOLD AND SILVER						
Carnegie Metals	Pittsburgh	13⅛	12	13⅜		
Con. Cortes	N. Y. Curb	*8	*8	*8		
Con. Virginia	San Francisco	*6⅛	*6⅛	*6⅛		
Continental Mines	N. Y. Curb			*15		
Dolores Esperanza	N. Y. Curb			*50	July, 1923	0.05
Premier Gold	N. Y. Curb	1⅜	1⅜	1⅜	De.17, Ja.4	Q 0.08
San Rafael	San Francisco			*28		
Tonopah Belmont	N. Y. Curb	2⅛	2⅛	2⅛	Se.15, Oc.1	0.05
Tonopah Extension	N. Y. Curb	*28	*24	*24	Apr. 1925	0.05
Tonopah Mining	N. Y. Curb	3⅜	3⅜	3⅜	Se.30, Oc.21	SA 0.07½
West End Consol	N. Y. Curb	*9	*8	*8	Mar., 1923	0.05
Yukon Gold	N. Y. Curb			*40	June, 1918	0.02

Stock	Exch.	High	Low	Last	Last	Div.
SILVER						
Beaver Consol	Toronto	*73	*67	*67	May. 1926	0.03
Canadian Lorrain	Toronto	*60½	*56	*60½		
Castle-Trethewey	Toronto	1.08	1.03	1.05		
Coniagas	Toronto	4.20	3.90	4.00	May, 1924	0.12½
Keeley	Toronto	1.53	1.50	1.50	Se. 1, Se.15	SA 0.12
Kerr Lake	N. Y. Curb	*82	*80	*80	Oc. 1, Oc.15	SA 0.12½
La Rose	Toronto	*10½	*10	*10	Apr., 1922	0.10½
Lorrain Trout Lake	Toronto			*55	July, 1925	0.05
McKinley-Dar.-Sav	Toronto	*15	*13	*14½	Oct., 1920	0.03
Mining Corp. Can	Toronto	3.35	3.15	3.26	De.30, Ja.15	Q 0.12½
Nipissing	N. Y. Curb	9¼	8¼	9	De.31, Ja.20	Q 0.15
Temiskaming	Toronto	*7	*7	*7	Jan., 1920	0.40
SILVER-LEAD						
Ahumada	New York	4⅛	4⅛	4⅛	De.18, Ja.5,	QX 0.15
Bingham Mines	Boston	44⅛	41⅛	44⅛	De.30, Ja.5	Q 1.00
Cardiff M. & M	Salt Lake	*51	*45	*45	Nov., 1924	0.10
Chief Consol	Salt Lake	3.25	2.85	3.10	Oc.10, No.1	Q 0.10
Consti'nMng.&Mill'g	Spokane	*30	*30	*30		
Erupcion	Boston Curb	1	1⅛	1	De.18, Ja.3,	Q 0.10
Federal M. & S	New York	89⅛	88	88		
Federal M. & S., pfd.	New York	77	76⅛	77	No.24, De.15	Q 1.75
Hawthorne Mines	N. Y. Curb	*9	*7	*7		
Hecla Mining	N. Y. Curb	*15⅛	*14⅛	*14⅛	No.15, De.15	Q 0.50
Highland-Surprise	Spokane	*17⅛	*15	*16⅜		
Iron King Mining	Salt Lake	*46	*26	*34⅛		
Keystone Mining	Salt Lake			*30	Au.12, Au.26	0.07½
Lucky Jim	Spokane	*16⅛	*16	*16⅛		
Lucky Tiger-Com	Kansas City	†6.75	†6.50		Dec. 20, 1926	0.12
Mammoth Mining	Salt Lake	2.55	2.45	2.50	De.17, De.23,	Q 0.25
Marsh Mines	Spokane	*2⅛	*2	*2⅛		
Park Utah	New York	6.15	6.15	6.15	De.15, Ja.2	Q 0.15
Plutus Mining	Salt Lake	2	2	2	Ja.10, Ja.15	Q 0.10
Prince Cons	Salt Lake			*1⅛		
Silver King Coal	Salt Lake	7.95	7.80	7.95	De. 16, Ja.3	0.25
Silversmith	Spokane	*34	*28½	*34	Oc.1, Oc.10	Q 0.02
Strattons Mines	Spokane	*43	*32	*33		
Sunshine M. Co	Spokane	*44	*40⅛	*44		
Tamarack-Custer	Spokane	*43⅛	*42	*42⅛	Sept., 1924	0.25
Tintic Standard	Salt Lake	11.00	10.87½	10.87½	De.11, Ja.3	0.30
Utah-Apex	Boston	6⅛	6⅛	6⅛	Oc.3, Oc.15	Q 0.25
IRON						
Bethlehem Steel	New York	47⅛	46⅜	46⅝	July, 1924	1.25
Cleveland-Cliffs Iron	Cleveland	80	74	75	Ja.15, Ja.25	Q 1.00
Colorado Fuel & Iron	New York	50⅜	44⅛	48	May, 1921	0.75
Gt. North'n Iron Ore	New York	21	19⅜	20⅛	Dec.6, Dec.28	0.75
Inland Steel	New York	43	41⅛	41½	No. 15, De.1	Q 0.62½
Mesabi Iron	N. Y. Curb	96	95	95		
Replogle Steel	New York	13	11⅜	12		
Republic I. & S	New York	62⅜	59⅜	60⅛	Fe.15, Ma. 1	Q 1.00
Republic I. & S. pfd.	New York	99⅜	99⅛	99⅛	Ma.15, Ap.1	Q 1.75
Sloss-Sheffield S. & I.	New York	127	123½	126	De.10, De.20	Q 1.50
Sloss-Shef. S.&I. pfd.	New York	108	107⅛	108⅛	De 20, Ja.3	Q 1.75
U. S. Steel	New York	114⅛	113	113⅜	De.1, De.30	Q 1.75
U. S. Steel pfd	New York	130⅜	130⅛	130⅝	No.2, No.29,	Q 1.75
Virginia I. C. & C	New York	47	47	47	Jan., 1924	1.50
Virginia I.C.&C.pfd	New York			80⅜	De.15, Ja.2,	2.50
DIAMONDS, PLATINUM, ALUMINUM, VANADIUM, TIN						
De Beers Consol	New York			32⅜	Ja.26, Ja.29	1.45
So. Am. Gold & P	N. Y. Curb	3⅜	3⅛	3⅜		
Alum.Co.of Amer	N.Y.Curb	71⅛	71⅛	71⅛		
Alum. Co. of Amerpf.	N.Y.Curb			102	De.15, Ja.15	Q 0.50
Vanadium Corp	New York	38⅞	37	38⅛	Fe.1, Fe.15,	Q 0.75
Patino M. & E	N. Y. Curb	25⅛	25	25⅛	Nov. 5, 1926	5 sh.
ASBESTOS						
Asbestos Corp	Montreal	24⅜	23	24⅛	Jan., 1926	1.50
Asbestos Corp., pfd.	Montreal	85¼	83	85⅛	De.31, Ja.15,	Q 1.75
SULPHUR						
Freeport Texas	New York	39⅜	37	38⅛	Ja.15, Fe.1	Q 0.50
Texas Gulf, new	New York	53⅛	50⅛	52⅛	De.1, De.15,	Q 1.00
MINING, SMELTING, REFINING AND GENERAL						
Amer. Metal	New York	44	42⅛	43⅜	No.19, De. 1,	Q 1.00
Amer. Metal pfd	New York			110⅛	No.20, De.1	Q 1.75
Amer. Sm. & Ref.	New York	141⅛	136⅜	138⅛	Ja.14, Fe.1,	Q 2.00
Amer. Sm.&Ref.pfd.	New York	121⅛	120⅜	121⅛	Fe.4, Ma.1,	Q 1.75
Consol. M. & S	Montreal	2.48½	2.46	2.48½	De.31, Ja.15	X 6.25
Federated Metals	N. Y. Curb	14⅜	13⅛	13⅜		
Newmont Mining	N. Y. Curb			68⅞	De.31, Ja.17,	0.60
U. S. Sm. R. & M	New York	35⅜	34⅛	35	Ja.6, Ja.15,	Q 0.87½
U. S. Sm. R.&M.pfd.	New York	46	45⅜	46	Ja.6, Ja.15,	Q 0.87½

* Cents per share. † Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. F, four weeks. I, Initial. X, Includes extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.; Spokane, Pohlman Investment Co.; Salt Lake, Stock and Mining Exchange; Henry Sachs, Colorado Springs, Colo.

LONDON QUOTATIONS—WEEK ENDED JAN. 11, 1927

Name	High	Low	Last	Last Div. Date	Amount
Aramayo Mines (25 frs.)	78/9	74/4½	78/9	Aug. 1926	15 p.c. †
British Platinum (£1)	3/6	2/6	3/—	Feb. 1925	2½ p.c.
Burma Corpn. (10 rupees)	14/7½	14/3	14/6	Feb. 1927	6 annas*
Bwana M'Kubwa (5s)	7/—	6/6	6/9		
Camp Bird (2s)	4/1½	2/6	4/—		
El Oro (£1)	4/9	3/6	4/4½	Nov. 1924	2½ p.c.*
Esperansa (10s)	—/4½	—/3	—/3		
Frontino & Bolivia (£1)	12/6	11/7½	12/6	Jan. 1927	5 p.c.
Mexican Corpn. (£1)	8/6	7/—	8/6		
Mexico Mines of El Oro (£1)	20/—	17/6	20/—	Dec. 1926	3¾ p.c.*
N'Changa Copper Mining	19/—	15/—	18/9		
Oroville Dredging (£1)	5/3	4/7½	5/—	Dec. 1923	3¾ p.c.
Ouro Preto (£1)	2/1½	2/—	2/—	May 1925	2½ p.c.
Rhodesian Congo Border (£1)	85/—	80/7½	85/—		
St. John del Rey (£1)	9/4½	8/9	9/—	June 1925	6½ p.c.
San Francisco Mines (10s)	31/3	30/3	30/6	Jan. 1927	25s.
Santa Gertrudis (£1)	14/3	13/7½	14/	Jan. 1927	3¾ p.c.
Selukwe (2s. 6d.)	11/10½	11/4½	11/6	April 1917	6¾ p.c.
S. Amer. Copper (2s.)	3/4½	3/2	3/3	Nov. 1917	75 p.c.
Tanganyika (£1)	49/—	41/3	48/9	Aug. 1926	7½ p.c.
Tomboy (£1)	3/3	3/—	3/3	July 1926	10 p.c.
Union Miniere du Haut-Katanga (Brussels)	9.500	8.500	9.050	July 1926	175 (‡)

* Free of British income tax. † Swiss frs. ‡ Belgian frs. and free of taxation